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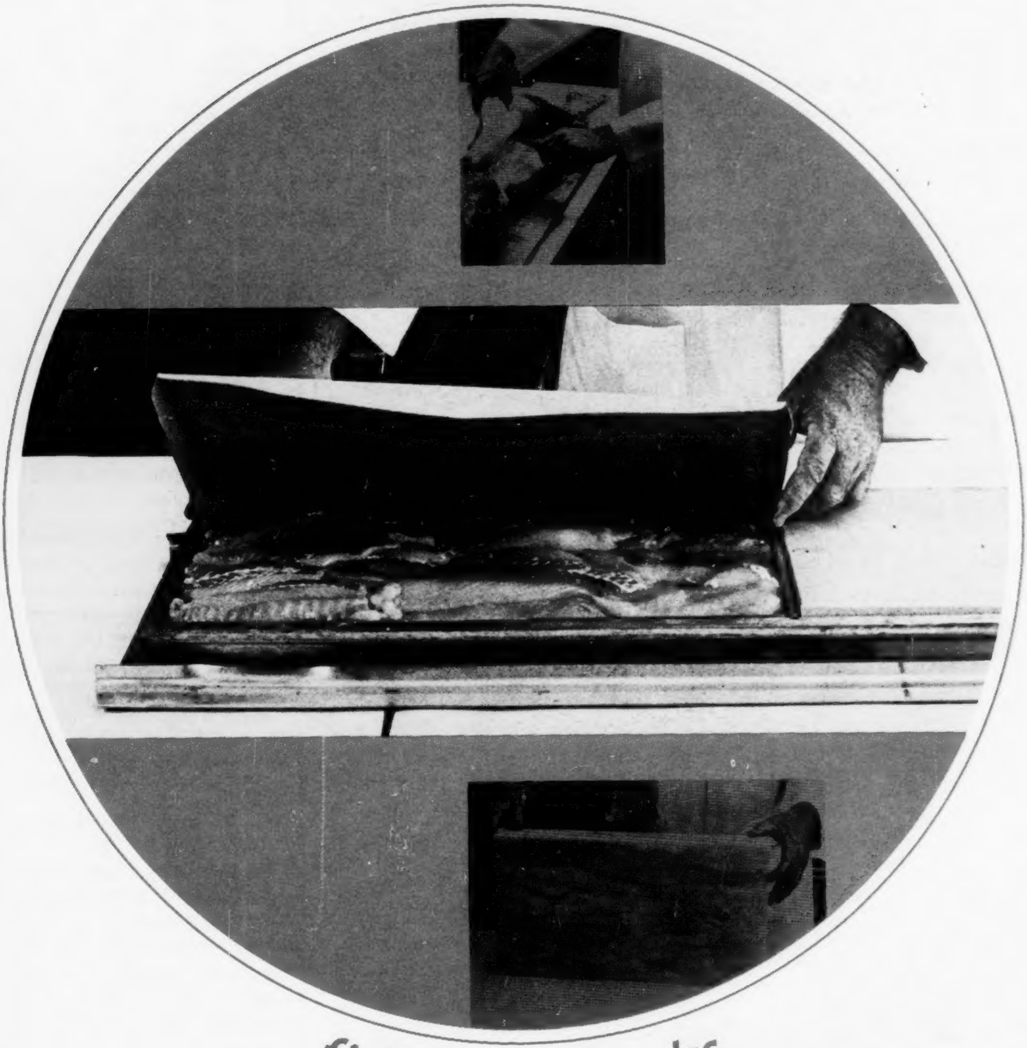

fish fillet blocks

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NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
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National Marine Fisheries Service

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A Concept for Assuring the Quality of Seafoods to Consumers

L. J. RONSIVALLI, C. GORGA, J. D. KAYLOR, and J. H. CARVER

ABSTRACT — For more than a decade numerous surveys of the quality of seafoods at retail counters have resulted in consistent adverse reports, and it has been concluded that the unreliability of the quality of seafoods is the major reason why their per capita consumption is so much lower than it is for beef, pork, or poultry. A concept for insuring the Grade A quality of seafoods was developed and tested in an attempt to demonstrate that the consumption of fresh fish will increase when their quality and image are improved. This paper describes the concept, its implementation under federal coordination, and its successful implementation by industry which has grown from a pilot operation involving five retail stores and about 200 pounds (91 kg) of fillets per week to over 200 stores and over 15,000 pounds (6,803 kg) of fillets per week — and still growing.

INTRODUCTION

For more than a decade Consumer's Union has published articles condemning the quality of fishery products available to the American consumer. The following quote (Anonymous, 1965) is a representative sample of that literature.

> "One likely reason for this country's low consumption of seafood—which was held at an average of 10 or 11 pounds a year per person for more than a generation—is that most people seldom get to taste the sweet, delicate flavor of fresh-caught fish. It's probable that this plentiful food, rich in protein, vitamins, and minerals and relatively inexpensive, goes a-begging because, by the time it reaches the dinner table, it has usually attained an age and condition warranting its religious connotation as a penance food."

Articles by other consumer groups have been even more damaging to the image of fish as food. Some of them have condemned the processors, because by their brand name they were the only identifiable elements in the distribution chain. The National Marine Fisheries Service (NMFS), previously the Bureau of Commercial Fisheries, was also implicated, because the U.S. inspection sticker was on some of the poor quality samples (Anonymous, 1961). (But in most cases, and certainly in the cases involving the inspection sticker, the products were of sound quality when they left the plant.)

The per capita (per year) consumption of fish in the United States is about 12 pounds (5.4 kg), while that of beef is about 120 pounds (about 54 kg), that of pork is about 60 pounds (about 27 kg), and that of poultry is about 50 pounds (about 23 kg). It is ironical that the protein source which is considered to be the most desirable from a health point of view should be consumed in the smallest quantity. However, per capita consumption of fish is not uniform throughout the country; and some data indicate that it is much higher in coastal areas (about twice the average) where fish of high quality is readily accessible. It is much lower in inland areas where the quality of fish available to consumers is relatively poor. It has been observed that when a consumer does not like a cereal he has purchased, he simply buys that of another brand, but when a consumer is dissatisfied with a fish purchase, he stops buying fish.

From earlier work, it was determined that the shelf life of a few seafoods held

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Table 1.—The approximate shelf life of cod fillets (Ronsivalli et al., 1973).

Temperature °F	Temperature °C	Approximate shelf life (days)
32	0	14
34	1.11	11
37	2.78	8
39	3.89	7
41	5.00	6
44	6.67	5
49	9.44	4
56	13.30	3

at 31°-33°F (−0.56°-0.56°C) is about 2 weeks from the time they are harvested. (The shelf life of a product, in this case, ends when it becomes unacceptable as a food; that is, the total time it takes for the product to change from Grade A to Grade B to Grade C and then to the point just before it becomes unacceptable.)[1] It has been established that the shelf life of fresh seafoods is affected mainly by the temperature at which they are held (Table 1). For example, if handling conditions are not strict and the temperature of fish fillets is allowed to rise from 32°F (0°C) to 49°F (9.4°C), the product shelf life will be reduced from 14 days to 4 days. This gives too little time for distribution, and by the time it is sold, it may well be less than Grade A in quality. Thus, the importance of temperature in the control of quality is evident. This requirement has been emphasized as has been that of packaging (Ronsivalli and Charm, 1975; Ronsivalli and Licciardello, 1976; and Slavin, 1961). While the quality of a seafood degrades relatively rapidly and must inevitably reach a stage of rejection as food, the rate of spoilage can be slowed by temperature control and protective packaging, and its quality can be measured to insure that product of poor quality is not

[1]U.S. Grade A means the highest possible quality with no evidence of spoilage, and having all the required product characteristics of size, shape, color, freedom from defects, etc. U.S. Grade B means that the product is of good commercial quality. It may not be as desirable in appearance, size, etc., but its eating quality (odor, flavor, etc.) is quite acceptable with only slight evidence of loss of the desirable eating quality. Grade C means fairly good quality. The product is wholesome and nutritious but may be substantially lacking in desired appearance. It may show evidence of slight to moderate changes, especially in flavor and odor, but still is free of offensive odors and flavors. Once the product shows evidence of bad odors which are usually, though not always, associated with objectionable taste, it is considered to be unacceptable, and its shelf life has ended. It should be emphasized that only U.S. Grade A products were used in this experiment, and only U.S. Grade A products are used under this concept.

sold. From the foregoing, it can be seen that in order to assure consumers that they can obtain high quality fish, it is necessary to impose strict quality control right up to the point of sale. Once consumer confidence has been gained, the effect of assured quality on the sales volume can be determined.

CONCEPT FOR AN IDEAL PROCEDURE

The major elements of a system that brings seafoods from the sea to the consumer include: 1) fishing vessels, 2) processing plants, 3) overland vehicles, and 4) retail outlets. Other intermediate elements include warehouses, freezer rooms, etc. In all cases it is important that the temperature be kept as close to 32°F (0°C) as possible for wet fish and as cold as possible for frozen fish, certainly not higher than 0°F (−17.8°C). In addition to keeping seafoods as cool as possible, they should be handled as quickly as possible, because they spoil at rates that are dependent on time as well as temperature. For the quality of seafoods to be reliable at retail, they must start at the highest quality, and then their quality must be maintained up to the point of sale. This can be accomplished by measuring the product quality throughout its distribution from the vessel to the retail stores and up to the day that the product is sold. The predetermination of pull dates, based on empirical data, is an effective way to insure the high quality without inflicting high inspection costs on the system. For maximum economic benefits, wet seafoods (unfrozen) could be displayed for a period during which their quality is at U.S. Grade A, removed near the end of their Grade A shelf life (about 1 week), frozen, and sold as frozen U.S. Grade A products. With this procedure, and using gas-impermeable packaging, the frozen products should remain at U.S. Grade A quality for several months to a year.

Figure 1.—The combined label used to identify products with the Grade A quality guarantee.

Figure 2.—Educational message displayed with guaranteed Grade A quality fillets.

CONCEPT IMPLEMENTATION

The concept was applied under federal coordination, and, later, it was assimilated by industry without any federal assistance.

Implementation of Concept Under Federal Coordination

Procedure

Federal technologists, inspectors, and marketing personnel collaborated with one processor and two stores of a supermarket chain to conduct the implementation of this program.

Fresh cod, cusk, flounder, haddock, ocean perch, and pollock that met the USDC Inspection Standard for Grade A were filleted at the Empire Fish Company, Inc.,[2] of Gloucester, a plant that is approved by the USDC Inspection Service. Fillets were inspected and packed in expanded-plastic trays containing absorbent pads and overwrapped with a self-adhering plastic film. The filled trays were labeled with the USDC inspection sticker, the U.S. Grade A symbol, and the logo identifying the product as being associated with this study (Fig. 1). The trays were packed in insulated master containers and taken by laboratory personnel to two DeMoulas supermarkets at Fitchburg and Leominster, Mass., respectively, that had been inspected and approved by USDC inspectors. At the markets the packaged fillets were weighed, priced, identified as to species, and displayed in mechanically refrigerated cases that were temperature controlled to 32°±2°F (0°±111C). Surplus fillets were held in a temperature-controlled cooler at 30°±2°F (−1.11°±1.11°C) and were later used to replace units as they were sold. Temperature profiles of both the display cases and the coolers in both markets were obtained by laboratory personnel. A sign to educate potential customers to the benefits of the product was placed adjacent to the fillets (Fig. 2) and this tactic was supplemented by a 30-second oral description that was issued by tape recording every 5-10 min-

[2]The names of collaborators are included only for identification. Their mention does not imply endorsement by the National Marine Fisheries Service, NOAA.

utes. An NMFS marketing specialist carried out the educational strategy which also included assistance to the store manager with recipe ideas, etc. Starting with the second or third day, the fillets were inspected daily by a USDC inspector; and when the quality of the fillets fell below U.S. Grade A, all of the remaining ones were withdrawn from sale and replaced with fresh fillets when they were available. The returned fillets were put in a freezer at the store and transferred frozen to the laboratory and held for observation to determine the commercial feasibility of converting fresh fillets to frozen fillets in their original package. Deliveries were to be made twice each week in accordance with direct requests by the chain's seafood buyer to the processor. This information was also relayed to laboratory personnel who contacted inspectors to provide them with the necessary information to set the inspection schedule. As the experiment progressed, and the Grade A shelf life of the product could be approximated, the frequency of inspection was reduced to the last few days of the expected duration of the shelf life. Laboratory personnel coordinated the entire project and checked the functions of the various elements to insure adherence to the experimental design.

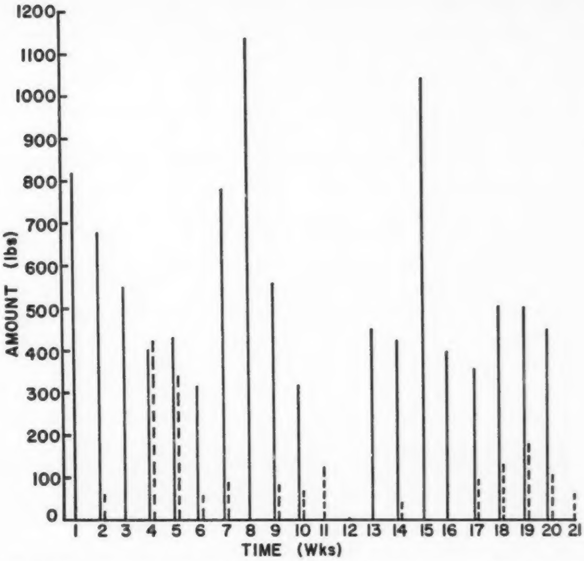

Figure 3.—Deliveries (solid lines) and returns (broken lines) of fish fillets.

Results and Discussion

As a result of this work, it is indicated that the concept of quality control can receive wide acceptance by the consumer, the processor, and the seller. While it is generally conceded that there is a relatively high rate of rejection of fish purchases among consumers, the most important demonstration of consumer satisfaction in this particular case was the complete absence of consumer complaints on the quality of the product during the entire 20-week period of the experiment which involved the sale of nearly 10,000 pounds (4,535 kg) of fillets of cod, cusk, flounder, haddock, ocean perch, and pollock. Consumers grew to accept the concept of quality control, even if it meant paying a higher price for product of guaranteed quality over products without guaranteed quality. At times, prices reached $1.00 per pound (0.45 kg) more than fillets of other brands. By the end of the experiment, it was reported that some consumers actively requested the U.S. inspected New England brand fish. They did not want regular, store-brand fish, and this was the first evidence that the buying judgment of the consumer was influenced by assured quality. As far as processors are concerned, the Empire Fish Company, which has remained with us throughout the experiment, has been and still is highly interested in the program. Other processors are now also demonstrating an interest in participating. Managers of the fish counters were unanimous in their praise for the program. They were pleased with the customer satisfaction and appearance and quality of the product. The prepackaging aspect was also highly desirable to them.

While considerable pertinent information was gained, it is not possible to quantify the effect of guaranteed quality on the sales volume because deliveries were unable to keep up with the demand. Nor was it possible to make any determination concerning the potential demand. As can be seen from Figure 3, there were no excesses in some cases. The amount of fillets that was returned (returns) varied greatly and erratically, ranging from a maximum of 422 pounds (about 191 kg) to 0 pounds per week. An apparent anomaly in the figure is the high rate of returns on the fourth and fifth weeks, but this is explained by the fact that the returns were from prior deliveries (e.g., the first and second weeks), and were not picked up earlier. Although one can detect much less than a trend, returns were proportionately higher at the beginning than at the middle or the end of the experiment; the largest deliveries were not followed by large returns—see Figure 3 and Table 2. Indeed, large

Table 2.—Schedule of deliveries and returns of Grade A fillets of six species of fish to two retail stores (in pounds).

Week	Delivery	Returns	Sales
10(18-22)76	820	0	820
(25-29)	680	58	622
11(1-5)	560	0	560
(8-12)	400	422	[1]−22
(15-19)	440	315	125
(22-26)	320	46	274
11/29-12/3	780	89	691
12(6-10)	1,150	0	1,150
(13-17)	550	84	466
(20-24)	320	64	256
(27-31)	0	126	[1]−126
1(3-7)77	0	0	0
(10-14)	460	0	460
(17-21)	430	38	392
(24-28)	1,050	0	1,050
1/31-2/4	400	0	400
2(7-11)	360	89	271
(14-18)	510	132	378
(21-25)	510	172	338
2/28-3/4	460	106	354
3(7-11)	0	82	[1]−82
	10,200	1,823	8,377

[1]The negative values included units from prior deliveries that were not picked up earlier.

deliveries were associated with consistently low returns. In general, returns were associated with the level of store prices. When prices stood at their lowest (e.g., during special sales), returns were negligible or nil. This was true especially for cod, cusk, and haddock. For ocean perch and pollock this relationship was not evident in the beginning, but it became evident toward the middle of the experiment. For flounder, the case is more difficult to determine. The lowest price occurred at the end of the phase and it had only one incidence. The relationship between high prices and high returns also appears to exist, but it could not be clearly determined from available data. A more complete understanding of these relationships would also require comparative data for meat and poultry. Besides, the sale of fish is clearly a function not only of price but also of quantity. Given the existence of a wide socioeconomic spectrum of customers, one can sell a low amount of fish at almost any price, but to sell a large quantity is another matter.

The introduction of underutilized species was expected to be facilitated if consumer confidence in the New England brand fish could be gained. The data collected in this experiment showed that this expectation is premature. There was three times as much haddock sold as there was cod, even though educational information was provided on the eating and nutritional similarities of cod to haddock, and even though cod generally sells for less than haddock. Cusk, which was cheaper than the more familiar species, hardly moved by comparison with the others (less than 2 percent of the total sales), and much of the cusk (about 43 percent) had to be returned. It appears that consumers purchased on the basis of species. Thus, we should not expect that underutilized species will sell as readily as conventional ones until consumer confidence in a brand starts to influence their buying judgment. Quality differences among displayed products might then become more important than species differences.

In order to capitalize on the strategy of freezing the product just before the end of its Grade A shelf life, it was necessary to know whether the product could simply be frozen in its original package (designed for maximum protection of the product whether frozen or unfrozen), or whether a repackaging step in the process—a costly step—was required. This aspect was studied in a limited way and the results obtained thus far show that freezing in the original package is a definite possibility. Both the tray and the packaging material retained their physical and aesthetic properties. The price label appeared shopworn, but it normally would be covered or replaced with a new price label. The inspection seal and Grade A label held up very well. There was some frost formed on the inner surface of the plastic overwrap, but it did not detract from the product which retained its original appearance. On thawing, the frost disappeared, and both the package and its contents had the same outstanding appearance and quality that have characterized this product throughout.

Implementation of Concept by Industry (Independently from Government)

A few months after this federally coordinated experiment was initiated, the Empire Fish Company and the First National Stores supermarket chain entered into an agreement (independently from government) to conduct a pilot operation involving five randomly selected stores and 200 pounds (about 91 kg) of fish fillets per week. Except for laboratory participation, the procedure used was the same as described above, and this independent effort adopted most of the quality control techniques embodied in the concept developed by the federal effort. From that exploratory step, the enterprise grew, and at last report, the Empire Fish Company was supplying about 200 First National supermarkets a total of about 15,000 pounds of fillets per week—and both the number of stores and the volume of product were still growing.

If the concept becomes assimilated by industry on a large scale, a number of long range benefits are possible and ultimately accruable to the consumer. Among these, the markets for high quality seafoods should expand to inland areas where a demand for these commodities already exists to a degree; a tendency to update and improve plants, vessels, and equipment would be generated; and higher levels of investment would be encouraged, especially with the new opportunities possible under this country's extended fisheries jurisdiction to 200 miles (124 km) and the relatively recent emphasis on the dietary benefits of fish.

ACKNOWLEDGMENTS

The authors acknowledge the cooperation and valuable assistance of the Empire Fish Company, Inc., the A&P Supermarket Chain, the DeMoulas Supermarket Chain, Joseph Mendelsohn and J. Perry Lane of the Gloucester Laboratory, Henry McAvoy, Marketing Specialist of the National Marine Fisheries Service Northeast Region, and numerous personnel from the Northeast Region's USDC Inspection Service.

The authors also acknowledge the financial support of the New England Fisheries Steering Committee's Task Force on Fishing Development and the moral support of Jake Dykstra, a member of that committee.

Finally, the authors acknowledge the strong encouragement and the support of the late Sam Favazza, Executive Secretary of the Gloucester Fisheries Commission.

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MFR PAPER 1277

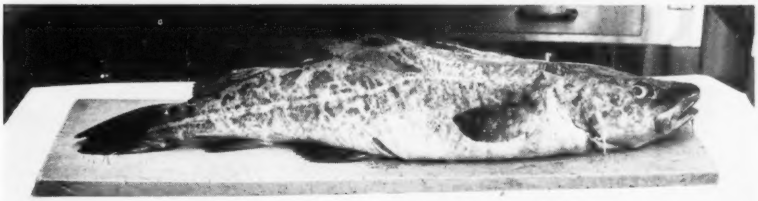
Preparation of Fish Fillet Blocks

JOHN J. RYAN

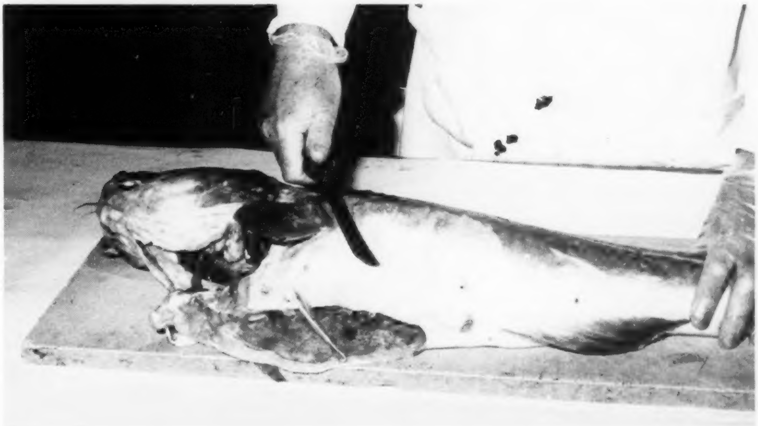
BACKGROUND

Frozen fish fillet blocks are used as the raw material in the manufacture of fish sticks and portions and other specialty items.

In 1976, nearly 400 million pounds of blocks were used for this purpose in the United States. Imports accounted for 379 million pounds with domestic production adding less than 0.6 percent to the total. Cod and pollock are the principal species used for making blocks. Iceland was the principal supplier followed by the Republic of Korea, Canada, Denmark, Norway, and Japan. Cod accounted for 48 percent of the total followed by pollock which accounted for 25 percent. Cod blocks were supplied by Denmark, Iceland, Canada, and Norway. Pollock blocks were supplied by the Republic of Korea with 61 percent of the total followed by Japan's 11 percent.



Medium-sized eviscerated cod.



First cut behind fin.

Remove nape area of fillet from collar bone.

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Cut along dorsal fin (close to the backbone) toward tail.

Weight (pounds)	Dimensions (inches)
13½	21 x 11½ x 1½
16½	19 x 10 x 2½
18½	19 x 11⅜ x 2½
49½	24 x 19½ x 3

PROCESSING METHODS

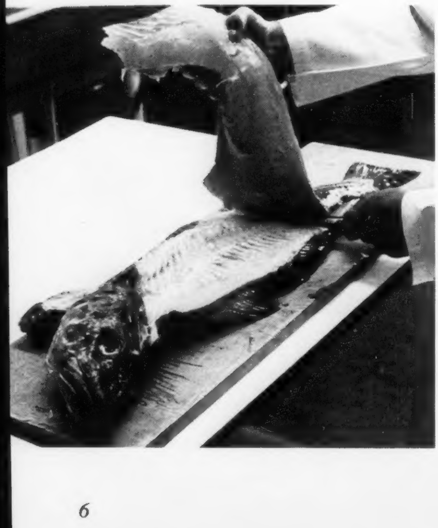
A fish fillet block is a uniform, cohering mass of usually skinless fillets frozen together under pressure. Because fish sticks and portions are cut to definite dimensions and weights, different sizes and shapes of fish fillet blocks are produced. The principal sizes and shapes of fish blocks being utilized in this country are as follows:

Additional sizes and shapes having limited use are as follows:

Weight (pounds)	Dimensions (inches)
10	13 x 11½ x 1⅞
11	17¼ x 11¼ x 1⅝
12½	21 x 10½ x 1½
13¼	17 x 11½ x 1⅞
13½	20 x 11⅝ x 1⅝
13½	20 x 11¾ x 1½
15	16 x 11¹/₁₆ x 2⅜
16½	19 x 10 x 2⅝
16½	18⅞ x 10 x 2.4
17½	21 x 11⅜ x 2⅝

Because fish sticks and portions are cut to specified dimensions and a specified number are placed in a package to arrive at a definite weight, it is important that the frozen block of fillets be of

At left, filleting: Reverse knife along backbone. Bottom left, remove fillet from fish. Below, skin fillet.



a uniform density. Generally, an acceptable block will not vary more than ⅛ inch in any dimension from those specified.

A typical method of preparing fish fillet blocks will be used as an example. Essentially, boneless and skinless fillets are carefully placed into a waxed, one-piece folding carton either parallel with or perpendicular to the long axis of the box. In both cases, the thick portion of the fillet is placed adjacent to an edge of the container, and the thin portion is placed into the middle. The depression so formed is built up with fillets until the desired weight is obtained. The containers are slightly overfilled with fish so that all surfaces are uniformly filled with every effort being made to avoid sloping surfaces, bad corners, or voids.

For freezing, the blocks are put into a wooden or metal tray and then placed into a multiplate compression freezer. Space sticks of the correct size are used to prevent deformation or bulging caused by excessive pressure during plate freezing. Freezing time should not exceed 3 hours, and the internal temperature of the product should be reduced to at least −50°F at the thermal center after thermal stabilization. Using the correct sized spacers, slightly smaller in depth than the containers, causes a very slight compression of the containers when the plates are lowered. This compression smooths out the surface of the fish. Finally, when all the container is filled with fish flesh, the compression forces the fillets to fuse together into a single block of fish.

Upon removal of the blocks from the plate freezer, the blocks are taken out of the tray and packed into a corrugated master container. Usually, four blocks are packed into a corrugated master container.

The series of photographs in this paper depicts the many steps involved in making a good quality block. They point out many of the details that go into block production that would be difficult to describe with words.

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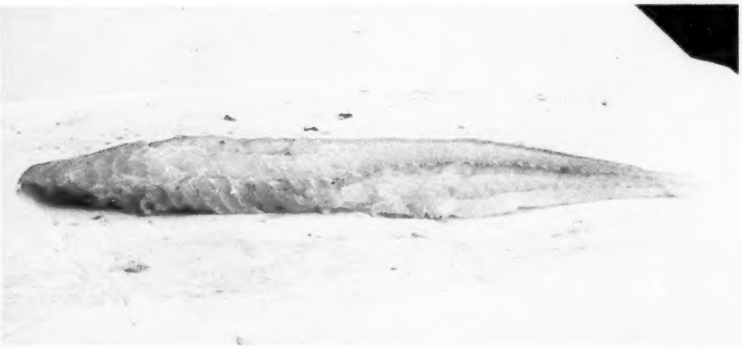
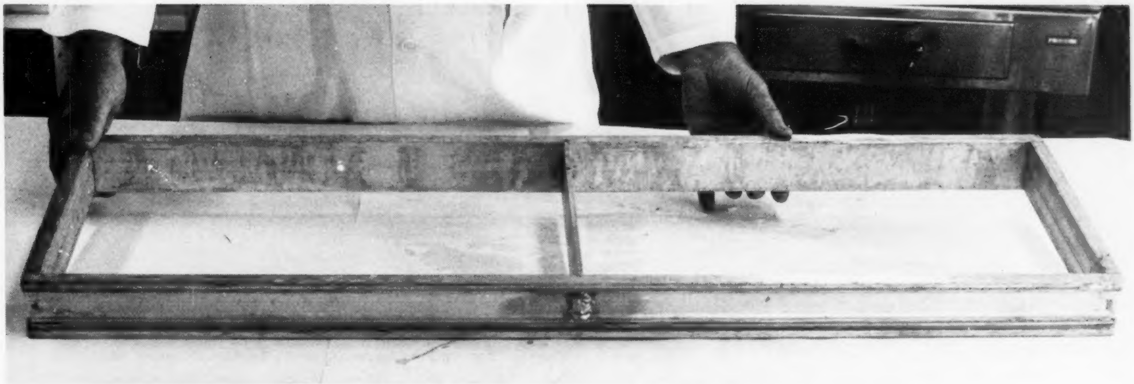
First cut to remove pin bones.

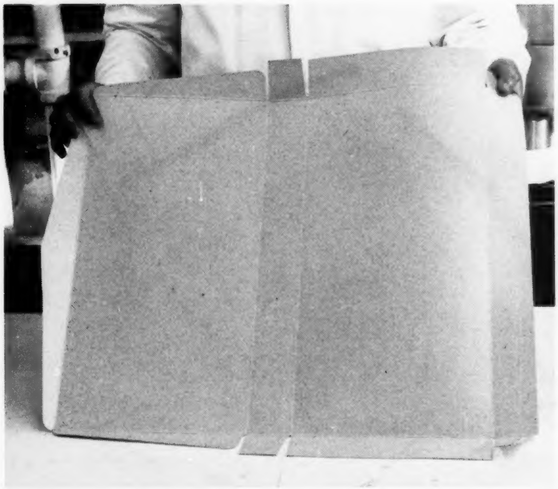
Second cut to remove pin bones.

Bones removed.

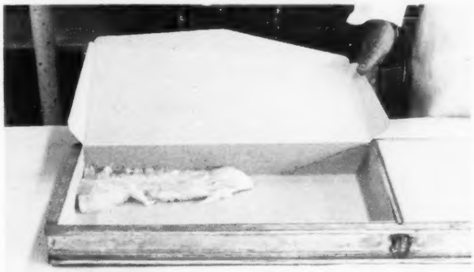
Counterclockwise from top: Removing black membrane; skinless and boneless fillet; cut thickest part of fillet on angle to permit better packing; and cut fillets in half.

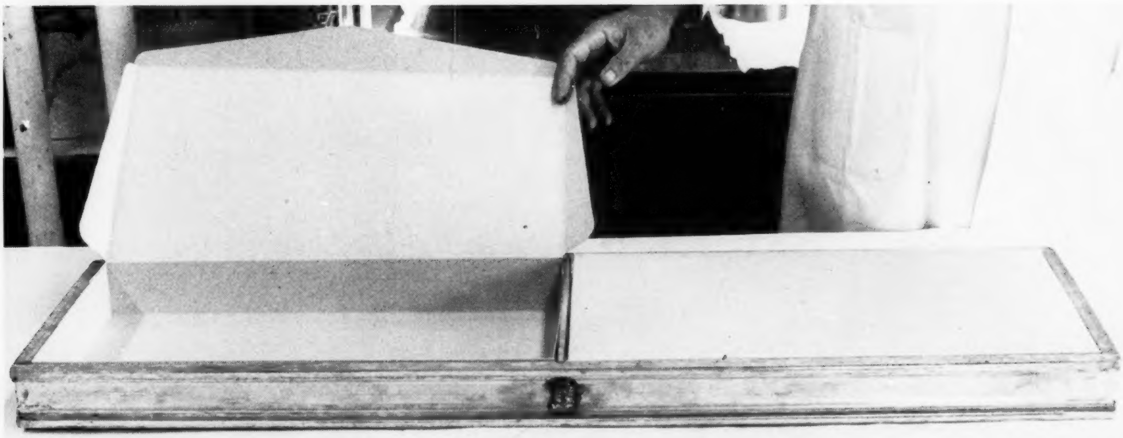


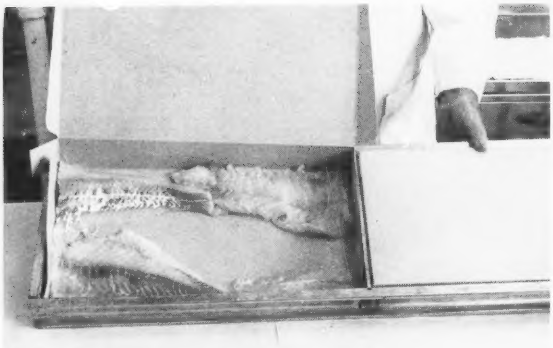




Counterclockwise from top: Block pan for 16½-pound block doubled with removable divider; unfolded block carton; folded block carton with all tabs overlapping on outside to prevent imbedded tabs; and square cut fillets butted into corner of carton.







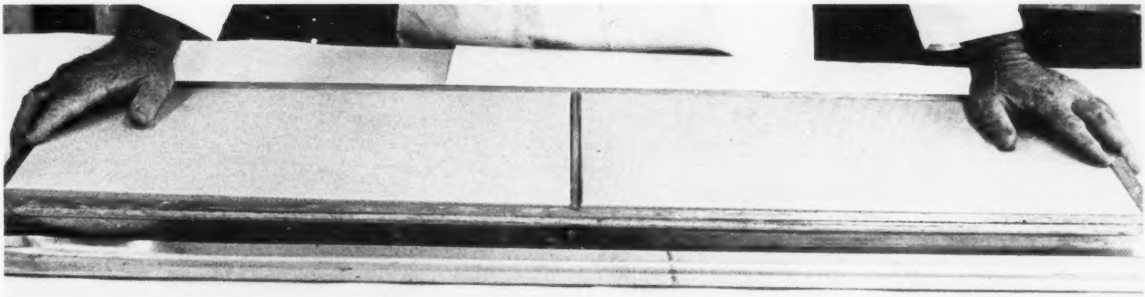
Packing fillets into carton, all corners filled first.

Partially filled carton. Long fillets should always be cut in half.

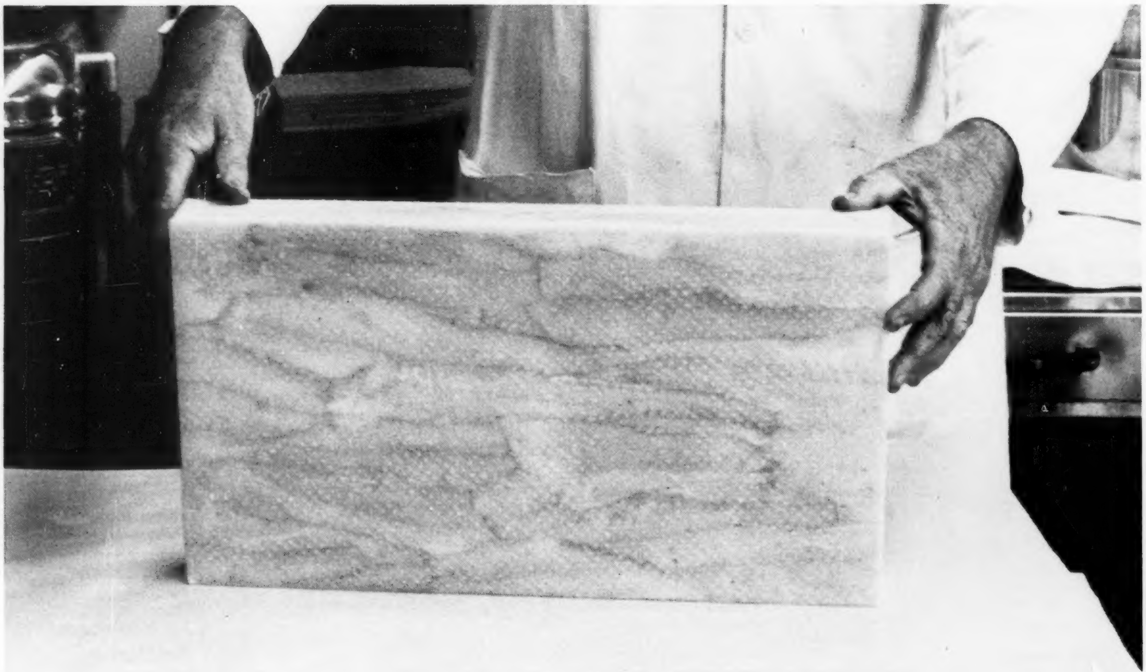
Completely filled carton. Top surfaces should be flattened and leveled.

Close carton. Overlapping cover edge is placed outside to prevent imbedding in block.

Finished carton. Top surface being smoothed.



Counterclockwise from top: Block cartons ready for plate freezing; plate freezer with plates up; plate freezer with blocks and plates compressed; and removing blocks from plate freezer.



Frozen block with square sio. and corners and absence of voids.

Frozen block side view.

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MFR PAPER 1278

Flavors in Fish From Petroleum Pickup

MAURICE E. STANSBY

ABSTRACT — All flavors noted in fish resembling petroleum oil are not derived from oil in water. Origins of various flavors found in fish are discussed. Many facts needed to understand the relationships between levels of petroleum in water and in fish and flavor of the fish have not been elucidated. Particularly, there are large discrepancies between reports by different investigators regarding levels of hydrocarbons and resulting flavor intensities. More research is needed to resolve these contradictions.

INTRODUCTION

It has been common knowledge for many years that when fish are caught and stored aboard the fishing vessel in ice, and bilge water containing oil accidentally comes in contact with the fish, the quality of the fish is impaired from a resulting off-flavor development in the flesh. The off-flavor can range from only a slight impairment, in cases where only small amounts of oil are involved, to a condition where the fish are completely ruined for human consumption. This kind of accidental contamination of fish has occurred frequently enough that there can be no doubt that when fish are stored with access to sufficient petroleum oil, a damaging alteration in flavor, which has generally been designated as a taint, develops.

In such cases as have just been described, the fish are dead at the time they have been in contact with water containing petroleum. We cannot justifiably conclude from such incidents that live fish living within waters contaminated by petroleum would develop such a taint. It appears quite likely that in the case of live fish, at least a part, if not all, of any petroleum entering the fish would, by the processes of metabolism, be altered, perhaps excreted so that there might be little or no alteration in the fish's flavor. It is the purpose of this paper to consider research findings dealing with the pick-up of petroleum by fish living in petroleum-contaminated waters with reference to alteration in flavor of their flesh.

Only a relatively small amount of research has been carried out on such matters as the effect of petroleum upon flavor of fish living in a petroleum contaminated environment. This is partly because interest in such environmental problems has not, until quite recently, been evident. A further hindrance to such research is caused by the rather difficult nature of such studies. Flavor of fish, or of any food material, is a completely subjective measurement which does not readily lend itself to use of scientific techniques. For direct measurement of flavors, it is necessary to use highly trained flavor panels and even when this is done, the subjective nature of the tests often leaves questions as to the accuracy of the results. On the other hand, it is possible to study flavors in an indirect manner by chemically measuring the components responsible for the different flavors. In the present instance, for example, a comparison of the content of hydrocarbons known to occur in petroleum found in fish living in petroleum-contaminated water would give presumptive evidence, at least to the effect that there might be flavor problems.

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Before discussion of research which has been carried out on matters specific to our interest, a short introductory section is included to give background on different types of flavors occurring in fish and from what sources they are derived. This information is needed in order to understand the differentiation between baseline flavor of fish in the absence of petroleum from flavors directly connected with the presence of petroleum.

GENERAL NATURE OF FLAVORS AND ODORS IN FISH

Three types of flavors, based upon the source from which they are derived, occur in fish, and each of these will be described briefly. These are natural flavors, unnatural flavors, and decomposition flavors.

Each species of fish contains many different flavor chemical components which blend together to give that species a particular flavor. Just as such other flesh foods as beef, pork, lamb, and chicken have composite flavors which enable us to distinguish one from another, so also such species as salmon, herring, and cod have different natural flavors, each characteristic for the different species. The flavoring components characteristic of each species occur both in the oil and in the protein of the fish. Ordinarily the most flavorful components are chemical entities which are dissolved in the oil of the fish. Nevertheless, fish protein also possesses some characteristic, though often quite bland, flavors.

Unnatural flavors occur in occasional specimens of a species which give these fish flavors not typical for the species. Such flavors occur especially when fish are consuming some type of feed which they normally do not eat. This may give rise to abnormal flavors, which sometimes are quite pronounced and which may be undesirable. For example, during certain seasons flatfish, such as sole, feed upon certain plankton which give rise to a flavor reminiscent of that of iodine. In other cases fish may consume, during a small portion of their

life span, feed giving a wide variety of abnormal flavors. In some cases, such flavors might resemble that of petroleum, even though no petroleum was involved. In other cases, the fish may acquire unnatural flavors by coming in contact with substances accidentally introduced into the water, petroleum being an example of this type of source. The fish could acquire such material by ingesting it through the digestive tract, by taking it into their respiratory system through the gills, or perhaps in some cases by direct absorption through the skin.

Decomposition of fish is the third process which can lead to off odors and flavors in fish. Bacterial decomposition (spoilage) leads to production of mostly volatile components like trimethylamine, ammonia, and hydrogen sulfide. These result in off odors, but during cooking of the fish most of the compounds responsible for the odors are volatilized so that the flavor of the cooked fish is altered much less than might have been indicated from odor observations. The components responsible for the natural flavors characteristic of the various species are highly labile and such flavors disappear rapidly, due probably to oxidation, as the fish are held at refrigerated temperatures.

Lipids (mostly oils) of fish are oxidized to some extent during storage in ice and to an extensive degree for fish frozen and held in cold storage. The oxidation products, which are mostly carbonyls, give rise to rancid types of flavors.

For research on flavors in fish the most common approach used by scientists has been to attempt to isolate from the fish chemical constituents most probably responsible for the flavor. Such research is time consuming and it involves intricate separation procedures to isolate the chemical constituents making up the flavor from hundreds or thousands of other compounds which are also present. The flavor components occur ordinarily in only trace amounts, which makes it most difficult to separate them from the other components, many of which are present in amounts several orders of magnitude greater than the flavor components. Identification of the isolated components is usually confirmed by mass spectrometry, sometimes used in conjunction with other criteria.

Many investigations do not go beyond the stage of isolation and identification of components which theory would indicate are likely causes of the flavor. In order to give the research results any real meaning, it is necessary to confirm that the chemical components isolated and identified really do possess the flavor of the fish which is noticed when the cooked fish is eaten. In order to carry out this additional research it is necessary to use a highly trained sensory evaluation panel of experts who are thoroughly familiar with the different flavors associated with fish. Such a panel can positively confirm whether the flavor of the fish is caused by the mixture of isolated and identified components and also can establish the ranges of concentration of the different components which make up the flavor. Unless this final step of a flavor evaluation is carried out, the results of a purely chemical study may be of little value from any practical application standpoint.

RESEARCH ON FLAVORS PICKED UP FROM PETROLEUM

The number of investigations and papers in this field is not huge and since most of the articles that have appeared deal with some limited aspect such as analytical methods, or are of a very general nature, the number of research projects set up to learn the nature of the phenomena involved or looking at the overall picture are very few indeed. Most of this review will deal with these latter types of research projects.

Some of the most comprehensive research in this field is coming from Torry Research Station (Mackie et al., 1972; Hardy et al., 1974; Howgate et al., 1976). These investigations include, for example, research on hydrocarbons isolated from brown trout caught in a stream which had been polluted by a 2,000 gallon diesel oil spill. The hydrocarbons were separated chemically from other constituents of the fish and were shown to be identical to hydrocarbons contained in the diesel oil. Furthermore, the odors and flavors of the hydrocarbons isolated from the fish matched exactly those from the hydrocarbons from samples from the same batches of diesel oil as had been spilled in the stream. Hydrocarbons in small trace amounts were isolated from brown trout caught in the same stream at sufficient distance upstream from the site of the spill so that no petroleum was present in the water. The odor of these hydrocarbons had no similarity to those from the polluted fish and were doubtlessly of biogenic origin. The odor and flavor of the hydrocarbons from these control fish were almost nil and were not at all similar to that from the hydrocarbons from the oil polluted fish. In another set of experiments by Torry Research Laboratory investigators (Hardy et al., 1974) the rate of uptake of hydrocarbons into the liver of wild codlings was measured. The fish were kept in tanks of seawater at the laboratory and the fish were fed cod liver oil containing Kuwait crude petroleum. As controls in another batch of fish, the oil fed was entirely cod liver oil. In these experiments there was a preferential absorption of carbon chain length of around 26 from the fish fed the petroleum but not from the controls. Hydrocarbons of chain length C_{15} to C_{21} were absorbed to an insignificant extent. In the hydrocarbon chain length range from C_{22} to C_{26} there was an increasing amount absorbed up to a maximum at chain length C_{26}. From chain length C_{26} to C_{30} there was a decreasing extent of absorption down to chain length C_{31}, at which no significant absorption into the codling livers took place. There was in no instance any evidence of preferential absorption by odd as contrasted to even hydrocarbon chain lengths. The first preliminary experiment, while too limited in scope to be conclusive, indicates that the codling possesses ability to preferentially absorb hydrocarbons of certain chain length. During a 6-month period after cessation of feeding of the crude petroleum by the fish, hydrocarbon levels had fallen to about half the maximum levels reached but were still about 65 times higher than in the control samples.

In another investigation, scientists in Australia's CSIRO (Commonwealth Scientific and Industrial Research Organization) Division of Food Preserva-

tion have been approaching this problem in a somewhat different way. For example, Shipton et al. (1970) investigated a kerosene-like flavor in mullet. Upon solvent extraction of such fish and examination and separation of hydrocarbons, they found characteristics similar to those of hydrocarbons found in crude oil. In other cases, however, Vale et al. (1970) found compounds apparently responsible for the kerosene-like flavors which arose from thermal decomposition of naturally occurring components in fish.

Deshimaru (1971) studied the effect on fish flavor of rearing yellowtail, *Seriola dorsalis,* in water containing crude petroleum oil. The amount of the crude oil in the fish rearing tanks was set at two levels, 10 ppm and 50 ppm, in different portions of the experiment. A third group of fish was held in water containing no petroleum but was fed feed consisting of fish containing 1 percent crude petroleum oil. The meat from the fish reared with 50 ppm oil in the water had a strong fishy flavor if the fish had been exposed to the oil-containing water for at least 5 days. No fish odor was observed, however, even after 13 days rearing with the oil when the level of oil in the water was only 10 ppm. A fishy flavor developed after more than 13 days exposure, but only to a slight degree. When the fish were fed with oil at the 1 percent level in the feed, a fishy flavor developed at a very low level after 5 days under test, but the degree of intensity had not increased by the end of the experiment (13 days). The presence of a C_{27} paraffin hydrocarbon was identified by gas chromatograph analysis of the flesh of yellowtail for the samples that had been held in water containing both 50 ppm and 10 ppm levels of petroleum.

Wilder[1] carried out quite different types of experiments on lobster meat and lobster liver (tomalley). In these experiments the living lobsters were coated with a fairly heavy layer of Bunker C petroleum oil. The lobsters were then, in some cases, returned to seawater in a 48-gallon tank in which the water was replaced at the rate of 1.6 gallons per minute. After exposure to running seawater in this way, lobsters were observed for disappearance of the oil. Within 6 hours less than 10 percent of the oil remained on the lobsters. After 96 hours only a few droplets of oil were visible at crevices on the ventral surface. Lobsters were then cooked and both the flesh and the liver examined by a taste panel. After 192 hours, more lobsters were withdrawn and subjected to the same treatment. In neither the meat nor the liver, after either 4 or 8 days exposure to the running seawater, was there any evidence of taint found by the panel. In another part of the experiment lobsters were fed bait covered with Bunker C oil. The lobsters readily consumed the bait, but again there was no evidence of taint after 4 or 8 days exposure to running seawater.

On the other hand, when untreated lobster were held in a tank of seawater containing 1 part of Bunker C oil per 1,000 parts of water (1,000 ppm) for 90 hours, both the meat and liver of the lobsters after cooking had a very decidely objectionable oily flavor. The liver samples had a stronger flavor than did the lobster meat. When the lobster treated in this way were held live in running seawater for as long as 3 weeks, the oily taste in the meat and liver, after the lobsters were cooked, still remained although at reduced intensity.

Some additional tests indicated that oil could be more completely removed from lobster by wiping if the dispersant, Corexit,[2] is used in water employed for the deoiling process.

A classical example of a petroleum-like odor in fish, which upon investigation proved to be something quite unrelated to petroleum, was documented by Motohiro (1962). As much as 5 percent of the canned chum salmon produced by the Japanese in the Bering Sea possessed a distinctly petroleum-like odor. After an extensive investigation, it was found that the odor was from dimethylsulfide which came from the precursor, dimethyl-2-carboxyethyl sulfonium sulfide. This substance was found in the digestive tract of a portion of the chum salmon packed in the north Pacific and it is believed to arise from certain algae consumed on occasion by salmon. Although the odor of the fish had what most observers described as a petroleum-type odor, it was shown conclusively that no petroleum product was involved in formation of the odor.

Mullet, possessing a petroleum type of flavor, have in some cases been found among the Australian catch. In a preliminary investigation, Grant (1969) suggested that, like the petroleum flavor found in canned chum salmon, this flavor in mullet might stem from decomposition of feed components to produce dimethylsulfide. In more extensive investigations, Connell (1971, 1974) showed that this mullet off-flavor arose from petroleum contamination. The volatile constituents from the tainted mullet were steam distilled and examined by gas chromatography-mass spectrometry. The resulting gas chromatograms and mass spectra showed close resemblance to those from commercial kerosene. It was also found that sediments in the Brisbane River in which the mullet spent part of their time also contained substances having gas chromatography-mass spectrometry characteristics similar to kerosene. It was concluded that the mullet probably included some of these sediments with their feed although they may have picked it up from the water.

Nitta et al. (1965) investigated the disagreeable odors found in fish occurring near petroleum refining plants at Yokkaichi, Japan. It was found that the odor of the fish flesh was similar to the odor of the effluent from the petroleum refineries. The investigation revealed that the odor could be picked up either from the water in the effluent or from bottom muds near the refinery. The concentrations of ether extract substances which were able to produce this effect were 0.01 ppm in water or 0.2 percent in the muds. It was determined that the substances causing the odors entered the fish through the respiratory system (gills). The odor became apparent in the fish flesh after only about 24 hours exposure to the effluents. Fish did not avoid the oily effluents; on the contrary, the fish seemed to be attracted by them.

[1]Wilder, D. G. 1970. The tainting of lobster meat by Bunker C oil alone or in combination with the dispersant, Corexit. Unpubl. manuscr., 23 p. Fish. Res. Board Can. Biol. Stn., St. Andrews, N.B.

[2]Reference to trade names does not imply endorsement by the National Marine Fisheries Service, NOAA.

Other investigations correlating petroleum-derived flavor or odor of fish with petroleum refining operations have been carried out (Krishnaswami and Kupchanko, 1969; Miyake, 1967; Ogata and Miyake, 1970; Yoshida and Uezumi, 1961; Yoshida et al., 1967). Of particular interest here, however, is the relationship between offshore drilling and oil taint (Mackin and Sparks, 1962; St. Amant, 1958; Menzel[3, 4]). The State of Louisiana (St. Amant, 1958) tabulated 60 complaints of oystermen with operations near offshore oil wells with about 40 percent of the complaints dealing with oily taint. Investigations showed that mud at oyster beds near such drilling operations had very high ether soluble extracts (up to 14,000 ppm). Usually the content of such extractives decreased as one moved away from the vicinity of the drilling operation, but in a few instances maximum oil contamination of the mud was at a distance of 500 feet or more from the site of the wells. It was found that this situation usually occurred with wells deeper than 10,000 feet and especially where the drilling operation employed a mixture of diesel oil with drilling muds. It was found that such drilling operations could result in tainted oysters if the oyster beds were within 5,000 feet of the wells in closed channels or within 2,500 feet in open bays. The oily taste in such oysters was found to persist for as long as 4-6 months after oil pollution ceased.

Oily taste from petroleum has been reported for shellfish other than oysters. Such reports have dealt with mussels (Nelson-Smith, 1970; Brunies, 1971) and clams (Hawkes, 1961).

GENERAL DISCUSSION

The amount of research carried out on the development of an off flavor, sometimes designated as taint, by absorption of petroleum oil or its components is not at all extensive. Fairly numerous articles have dealt, often superficially, with the presence of such flavors in fish, but very few research papers have been published in which the subject is investigated, even covering only a small aspect, in any kind of thorough and systematic way. I could find no research results on development of such flavors under Arctic conditions.

Petroleum-like flavors have been widely reported to occur in fish, but frequently when such flavors are further investigated they are found to be derived not from any petroleum precursor but rather from some alteration in naturally occurring components of the fish. Nevertheless enough instances of petroleum-like flavors in fish have been investigated and fully documented that the flavor arose from a petroleum product or one of its components, to leave no doubt that such products definitely can give rise to off flavors in fish.

Taint type flavors can occur by mere contact of the surface of the fish with petroleum. This occurs only when relatively large quantities of petroleum are involved. The petroleum and its flavor can in such cases be completely removed, or nearly so, by washing in running water with the removal facilitated by use of a detergent. In the more usual case the petroleum is picked up from the water by the fish either directly from the water through the respiratory system or from feed through the digestive tract. In such cases much less oil is required to bring about the effect and the off flavor is removed only by removing the fish from a source of oil. The pickup of oil in these cases is usually a slow process requiring days or weeks of exposure and reduction and elimination of the flavor is an even slower process requiring weeks or months of residence of the fish in an oil-free environment for complete removal of flavor or odor.

The vast predominance of research in which fish are exposed to waters containing petroleum or its components and then, after suitable intervals, are examined for flavor pickup have used relatively high concentrations of oil in the water, far more than ordinarily would occur under normal circumstances in the natural environment except under most unusual circumstances. Levels used generally are of the order of parts per million. For example Deshimaru (1971) exposed fish to water containing either 10 ppm or 50 ppm oil and fed fish feed containing 10,000 ppm of oil; Wilder (see footnote 1) exposed lobsters in tanks of water containing 1,000 ppm oil. The level of oil in waters occurring as a result of discharge of oil by industrial operations are many orders of magnitude lower than such levels. Ordinarily, levels are at parts per billion, even at parts per trillion, concentration. The only cases where many parts per million levels would occur are immediately adjacent to a massive oil spill or perhaps at a discharge pipe coming directly from a processing or manufacturing plant. Even then such levels of the order of parts per million are very transitory and owing to dilution soon diminish to lower levels. Because of these circumstances the results of most of the research reported in the literature on taint-like flavor picked up in controlled experiments does not necessarily reflect what happens in the usual environment. Based upon the degree and rate of development of taint in what controlled experiments as have been reported and where far greater levels of oil were used than would be encountered in open natural waters, it is the belief of this reviewer that taint from petroleum oil would never result from fish living in open ocean waters (barring some major catastrophe such as the *Torrey Canyon* incident, and then only for a short time span). Taint is a common occurence when fish are accidentally dipped in oil or oil-water emulsions such as might occur in a restricted hold aboard a fishing vessel. It probably also occurs occasionally in streams on very restricted bays or harbors where large volumes of oil accidentally come in contact with the fish. There is no evidence for its occurrence either for fish in the open sea or even in large bays with moderate to considerable discharge of oil from industrial operations.

Information on the level of petroleum-derived components in fish which barely are sufficiently high to cause detectable flavor are still too incomplete to give any indication of what levels might be tolerable. Ineson and Packham (1967) report threshold odor concentrations for certain petroleum products in water. These range around

[3]Menzel, R. W. 1947. Observations and conclusions on the oily tasting oysters near the tank battery of the Texas Co. in Crooked Bayou at Bay Ste. Elaine. Unpubl. rep., 6 p. Tex. A&M Res. Found., Proj. 9.

[4]Menzel, R. W. 1948. Report on two cases of "oily tasting" oysters at Bay Ste. Elaine oilfield. Unpubl. rep., 9 p. Tex. A&M Res. Found., Proj. 9.

100 ppb to 2 ppm for most crude or refined petroleum oil. Research is needed to yield information on maximum levels of such compounds that can occur in fish without resulting in any perceivable off odor or flavor.

What, then, do we know, based upon the few experiments described? With the limitations that most of the experimental work has dealt with concentration of petroleum several orders of magnitude greater than occurs in open waters and that none of the research was carried out under Arctic conditions, the following conclusions can at least tentatively be reached.

Petroleum reaches the marine organisms primarily through the water column, but may come from heavily contaminated mud or other sedimentary bottom. A major mode of entry is through the respiratory system, although it can also be picked up in the feed and there is no evidence at all to rule out that the food chain may not be of equal importance as a mode of entry. Taint types of flavors have been reported in at least one instance (Nitta et al., 1965) with as little as 0.01 ppm petroleum in water which has been in contact with fish for no longer than 24 hours.

Fish preferentially absorb hydrocarbons with chain length in the range of C_{22} to C_{30} with a maximum at C_{26}, and odd and even carbon chain length hydrocarbons are absorbed at about the same rates. There is no agreement among investigators as to the levels of petroleum in water needed to bring about off flavors in the meat of the fish. Thus Deshimaru (1971) reported that fish in waters containing 10 ppm of petroleum within 13 days exposure developed no fishy odor, yet Nitta et al. (1965), in experiments in natural waters, reported definite off odors developed in fish exposed for only 24 hours to levels of petroleum of only 0.01 ppm. While differences in type of petroleum and varieties of fish in different instances doubtlessly are important, such wide differences in threshold concentrations of three orders of magnitude plus 13 times difference in exposure time seem hard to account for on any such basis.

Retention of off odors after removal from the pollution may require as long as 6 months or more before disappearance of the off flavor. On the other hand, if the contamination occurs only as a result of external application, as in the experiments of Wilder (see footnote 1) the off-flavored meat of the fish can be returned to normal after only a few hours holding in pure running water.

Although several investigators have isolated, from fish or other marine organisms which possessed an off or taint odor, compounds having chemical characteristics closely resembling petroleum hydrocarbons, there has been no identification of single compounds nor groups of mixed, identified compounds which possess the characteristic "taint" flavor resulting from exposure of marine organisms to petroleum.

The area of research in this field which has been most neglected and in which more work should certainly be undertaken is a definitive evaluation of the maximum concentration of different kinds of petroleum in water in which fish can reside without picking up petroleum types of flavors. In what few reports on this matter exist in the literature there is such a complete disagreement among levels found which are said to lead to petroleum flavors or odors in the fish that we really know nothing definite.

A recent research trend has been toward looking at what happens to fish when they live at the bottom near sediments which contain oil. At Torry Research Laboratory (Howgate et al., 1976), research is at an early stage on looking at effects on flavor of fish which have been kept close to mixtures of sand and petroleum under laboratory holding conditions. Work on more general effects of petroleum on fish held under similar laboratory conditions is underway at the Northwest and Alaska Fisheries Center. Most research up until recently has involved effect of oil suspended or dissolved in the water column. It will be interesting to find what differences occur between effect of oil in sediments and oil in the water column as such research proceeds.

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MFR PAPER 1279

The Pacific Northwest Commercial Fishery for Striped Bass, 1922-74

NORMAN B. PARKS

The striped bass, *Morone saxatilis*, is a native of the east coast and was introduced in Pacific waters in the 1870's. It is now successfully established in northern California and in the Pacific Northwest. In the Pacific Northwest it had been taken commercially in five rivers in southern Oregon, but that state passed a law in 1975 that ended the fishery the following year. This report describes the commercial fishery in the Pacific Northwest and the events leading to the spread of the species on the West Coast.

STRIPED BASS INTRODUCTION AND RANGE EXTENSION

Striped bass were introduced to the Pacific Coast in 1879, when 132 small fish which had been shipped from New Jersey were planted in San Francisco Bay, Calif. An additional plant of 300 small bass was made in the same waters in 1882 (Morgan and Gerlach, 1950). In several subsequent years up until 1900, transfers were attempted within California and by 1889 a fishery was well established in the San Francisco Bay area (Hart, 1973).

"Considering the small number of fish introduced and their remarkable increase in a few years, the results obtained from the introduction of striped bass into California is one of the greatest feats of acclimatization of new species of fish in the history of fish culture," noted Scofield and Bryant (1926).

From these small plantings in San Francisco Bay the striped bass has spread along the Pacific Coast. Within 20 years of the initial plantings the range of the species extended to southern Oregon. At present its range extends from 25 miles south of the California-Mexico border to Barkley Sound, British Columbia (Miller and Lea, 1972). However, they are not common south of Monterey, California, or north of the Siuslaw River, Oreg. (Fig. 1). Occasionally, striped bass have been caught in the Columbia River but only periodically and in small numbers. In Oregon, the bass are most abundant in the Coos and Umpqua Rivers.

SPECIES DESCRIPTION

The striped bass, characterized by the seven or eight longitudinal stripes following the scale rows, attains a maximum weight of approximately 80 pounds (36.3 kg) on the Pacific Coast (Fig. 2). The average weight of those taken commercially in the past in Oregon rivers was about 6-12 pounds (2.7-5.4 kg)[1].

THE COMMERCIAL FISHERY

From the information available, it appears that striped bass were first taken in commercial quantities in Coos Bay in 1922. Partial landings for 1928 were 8,200 pounds (3,719 kg); for 1929, 8,300 pounds (3,764 kg); and for 1930, 13,400 pounds (6,077 kg) (Morgan and Gerlach, 1950). Statistics for the entire catch are available since 1931, when the catch in Coos Bay was 18,050 pounds (8,186 kg).

[1]Mullen, Robert E., 1972. Ecology of shad and striped bass in coastal rivers and estuaries. Manage. Res. Div., Fish Comm. Oreg., Public Law 89-304, Program Annu. Rep. July 1, 1971 to June 30, 1972, August 1972, 31 p. (Typescript).

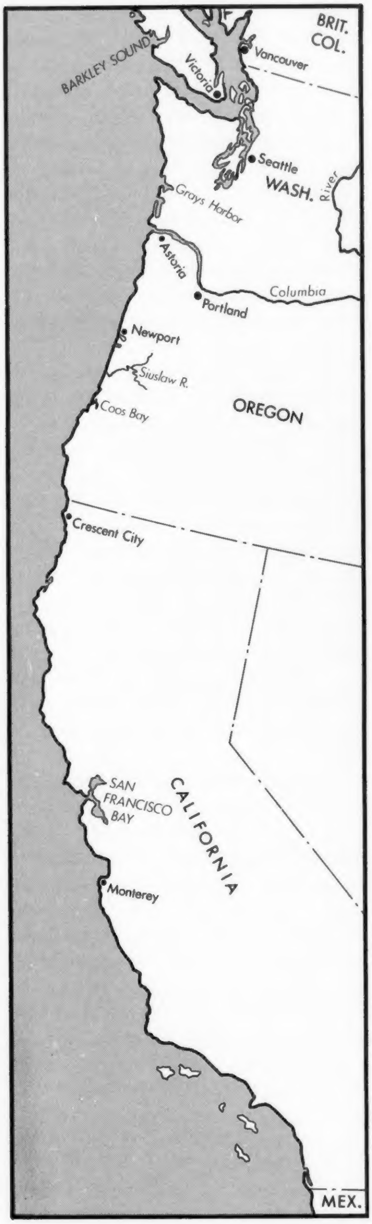

Figure 1.—West coast range of striped bass.

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In the middle and late 1930's, small commercial catches of striped bass were made in the Smith or Umpqua Rivers, beginning in 1940 in the Coquille River, and beginning in 1946 and 1950-51 in the Siuslaw River (see footnote 1). Table 1, which averages data from Mullen by 5-year periods, gives the average annual commercial landings of striped bass by coastal streams from 1931 to 1974. The largest catch was made in 1945 when a peak of over 250,000 pounds (113,639 kg) was landed. In recent years, the commercial

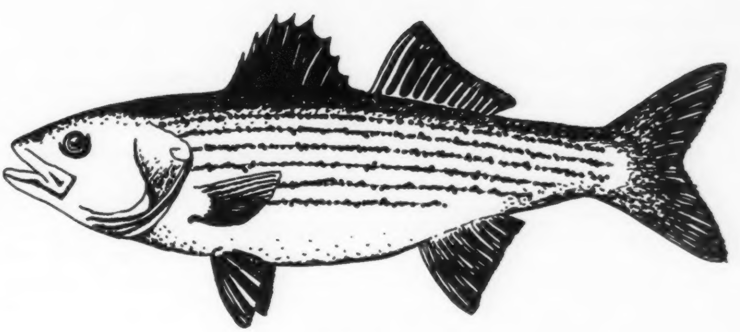

Figure 2.—Striped bass, *Morone saxatilis*.

Table 1.—Average annual commercial landings of striped bass in Oregon coastal streams, 1931-74[1].

Year	Average commercial landings (pounds)					
	Siuslaw	Smith	Umpqua	Coos	Coquille	Total
1931-35	—	[2]12		22,030	—	22,043
1936-40	—	36		48,989	18	49,037
1941-45	—	6,467		99,527	1,519	107,513
1946-50	23	5,474		83,420	725	89,642
1951-55	9	619	2,117	21,207	1,578	25,530
1956-60	209	1,055	7,788	13,317	1,188	23,558
1961-65	321	797	19,386	27,730	923	49,157
1966-70	245	1,841	18,825	17,526	679	39,119
1971-74	817	1,593	36,956	9,376	246	48,988

[1]Source: Mullen (see text footnote 1) for 1931-71; Jerry MacLeod, Aquatic Biologist, Oreg. Dep. Fish and Wildl., Coos Bay, Oreg., pers. commun. for years 1972-74.
[2]Smith and Umpqua Rivers combined through 1950.

catch in the Umpqua River increased while the Coos River catch generally dropped off (Table 1). Since 1960, total commercial catches of striped bass from the five rivers listed in Table 1 have ranged from 27,000 (12,449 kg) to nearly 69,000 lb (31,293 kg).

In 1975 Oregon passed a law against commercial fishing for striped bass. The law went into effect in 1976, and now striped bass are taken only by recreational fishermen.

Because the quantities taken commercially were extremely limited, striped bass have been primarily sold as a fresh frozen product, with some sent to California, and some to eastern markets.

A commercial fishing season was authorized in past years for striped bass and American shad, *Alosa sapidissima*, on Oregon's Siuslaw, Smith, Umpqua, Coos, and Coquille Rivers (Fig. 3). Most commercial fishing was conducted in the tidal portion of each river although two kinds of gillnet, set-nets and drift-nets, could be legally used in the bays (see footnote 1).

The commercial fishery for striped bass was closely related to the shad fishery in the five southern Oregon rivers. Morgan and Gerlach (1950) state that in Coos Bay no fishermen were known to fish solely for striped bass, although when bass were observed in large numbers, the relatively fragile shad nets were pulled and replaced with heavier gear. This probably did not happen more than two or three times during a season, but good catches of striped bass were made at such times. The striped bass fishery was limited to the season of the shad fishery and was more or less incidental to it (Morgan and Gerlach, 1950).

Prior to the ending of commercial fishing in Oregon for striped bass there had been few recent changes in the commercial fishing regulations. The major regulations, consisting of mesh size, gear type, and season restrictions, were primarily designed to protect

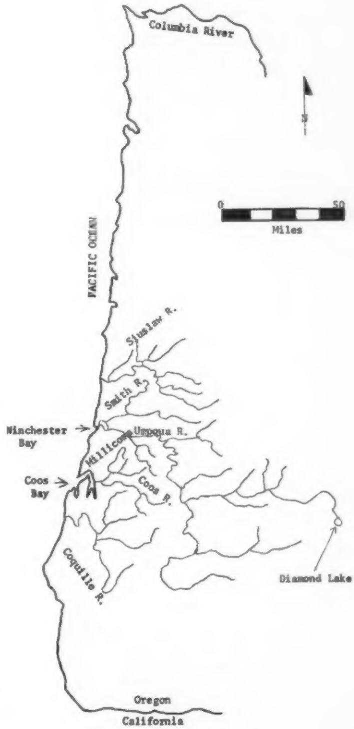

Figure 3.—Location of western Oregon rivers that were the site of commercial fishing operations for striped bass (see text footnote 1).

spring chinook salmon, *Oncorhynchus tshawytscha*, in the early spring and steelhead trout, *Salmo gairdneri*, in the summer. In the set-net fishery, each fisherman was allowed to fish six nets

while drift-net fishermen were restricted to one net. Each fisherman was required to sell his catch to a licensed wholesale fish buyer to facilitate record keeping, tax collection, and biological sampling (see footnote 1).

CURRENT TRENDS AND FUTURE STATUS

The striped bass is a very popular target of recreational fishermen in California and Oregon. In California, increasing fishing pressure by recreational fishermen resulted in the fishery being closed to commercial operations in 1935. In Oregon, the Legislature passed a law in 1973 making the striped bass a game fish but allowing it to be taken incidentally during the commercial shad fishery. The Oregon Fish Commission (since merged with the Wildlife Commission to create the Oregon Department of Fish and Wildlife) was directed to develop methods to minimize the incidental take of striped bass while shad fishing. The commercial shad season was delayed and some deadlines (or boundaries) modified to reduce the chances of catching striped bass. In 1975 the Legislature passed a law prohibiting the commercial take of striped bass. This law went into effect in 1976. In 1978 gear restrictions will be implemented, limiting the gillnet mesh strength to 69 denier, which will still permit the harvesting of shad but allow most striped bass to break free of the nets.

The northern range of striped bass stocks capable of supporting a fishery appears to be limited by environmental factors. Temperatures of 60°F (15.6°C) and above are believed necessary for spawning, which occurs from April in California to June in Oregon, and an extensive tidal estuary also appears necessary for a nursery area and wintering ground (Forrester et al., 1972). These factors make it unlikely that striped bass will become established in areas further north along the west coast. Striped bass will likely be strictly a recreational fish in the years ahead.

ACKNOWLEDGMENT

Jerry MacLeod, currently staff biologist, Office of the Director, Environmental Management Section, Oregon Department of Fish and Wildlife, Portland, Oreg., kindly contributed information on striped bass legislation in Oregon.

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Strandings of Shortfin Squid, *Illex illecebrosus*, in New England in Fall 1976

F. E. LUX, J. R. UZMANN, and H. F. LIND

INTRODUCTION

The shortfin squid, *Illex illecebrosus*, was unusually abundant in inshore waters of northern New England and eastern Canada in the summer and fall of 1976. During the fall of that year, beginning in about mid-October, massive strandings of live individuals of this species took place along the eastern and southeastern shores of Cape Cod Bay (Fig. 1).

While strandings of shortfin squid have been reported before, the extent and nature of the 1976 strandings made this an unusual occurrence. We therefore looked into the matter in an effort to learn something about the numbers of squid involved and possible reasons for the strandings. What follows is a report of findings, including notes on biology, distribution, and behavior of this squid.

Although there is another common squid in the New England area, the longfin squid, *Loligo pealei*, only the shortfin squid (Fig. 2) is known to strand en masse. Only the shortfin squid was seen in the 1976 strandings.

DISTRIBUTION AND FISHERY

The shortfin squid is distributed in considerable abundance from about Cape Hatteras to Labrador in offshore waters, where it lives from late fall to spring. With vernal warming it moves into more coastal waters, particularly in the area between Cape Cod and Newfoundland, where it remains until temperatures drop in the fall. Little is known of its breeding habits, except that it spawns at some time during its offshore phase, probably in winter or spring and beyond the continental shelf edge. It appears likely that it dies after spawning (Squires, 1967; Mesnil, 1977).

The principal fishery in the New England area is while the species is on offshore grounds and somewhat concentrated along the outer edge of the continental shelf. Most of the catch is by foreign trawlers. The total reported catch by all countries in areas off New England and Middle Atlantic states in 1975 was about 15,000 metric tons (ICNAF, 1977).

The inshore fishery for shortfin squid during summer and fall months has been primarily a Canadian one, particularly in coves and bays of Newfoundland. In recent years prior to 1976 it

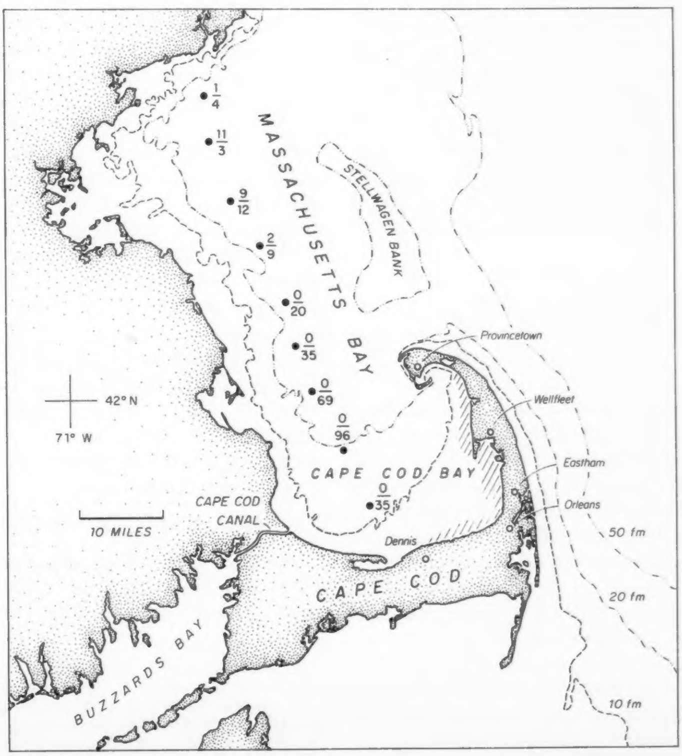

Figure 1.—Shore area of greatest strandings (shaded) of short fin squid in Cape Cod Bay during fall 1976, and numbers of this squid caught per ½-hour tow at otter trawl stations in fall 1975-76 *Albatross IV* cruises. The number above the line at each station is the number caught during Cruise 75-12 (22-23 Oct. 1975); the number below the line at each station is the number caught during Cruise 76-09 (21-22 Nov. 1976).

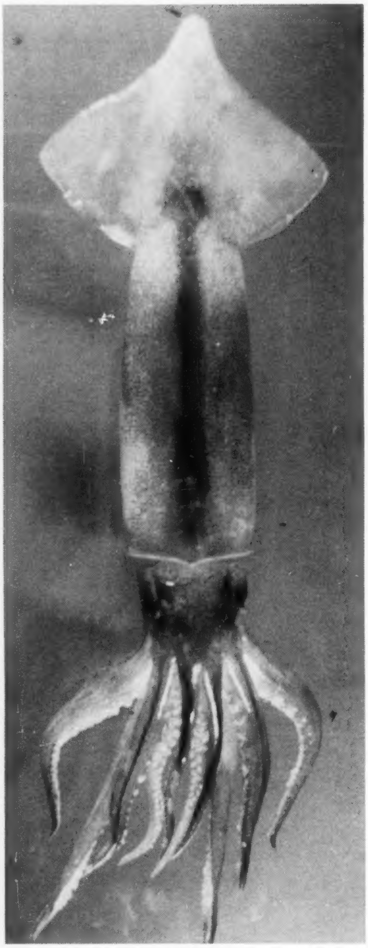

Figure 2.—An adult shortfin squid, *Illex illecebrosus*. (Photo by D. Flescher, NMFS).

generally has not been found in large numbers inshore in New England. In the summer and fall of 1976 this squid was exceptionally abundant inshore from Newfoundland to Cape Cod. Fishermen along the northern New England coast frequently commented that they had never seen so many. A small fishery developed for it and about 230 tons were landed at various ports, including Gloucester and Provincetown, Mass. (Prybot, 1977). There have been no reported U.S. landings of this species in recent prior years.

The unusually high abundance of this squid in Canadian waters is reflected in the inshore Newfoundland catch of 9,800 tons in 1976, compared with 3,200 tons in 1975; however, there were no known large strandings on Canadian shores in 1976[1].

Reports from commercial fishermen indicated that shortfin squid became abundant in Cape Cod Bay (Fig. 1) in late July. It later was abundant enough so that several thousand pounds sometimes were taken in a single otter trawl haul in this area. Commercial catches in Cape Cod Bay had declined greatly by late November.

RESEARCH VESSEL CATCHES

Some idea of relative abundance between fall 1975 and fall 1976 in Cape Cod and Massachusetts Bays can be gathered from otter trawl catches during routine surveys by the NOAA RV *Albatross IV* (Fig. 1). As the data show, no shortfin squid were caught in Cape Cod Bay in 1975, while they were numerous, up to 96 individuals per one-half hour tow, in 1976.

The catch per tow of shortfin squid on Georges Bank, in the Gulf of Maine, and off southern New England on this same cruise (*Albatross IV*, Cruise 76-09) also was a good deal higher in fall 1976 than in earlier surveys. The usual catch in past fall surveys has been about 1 kg per tow, while in 1976 it averaged about 10 kg per tow.

The temperature preference of shortfin squid around coastal Newfoundland is about 7°-15°C, although they are trawled offshore on the bottom at colder temperatures of about 1°-9°C (Squires, 1957). The bottom temperatures at the Cape Cod Bay *Albatross IV* stations 21-22 November 1976, were about 8°-9°C and, therefore, within the normal range for this squid.

STRANDING REPORTS

The first reports of the strandings in 1976 were from the Cape Cod Bay shore of Eastham, Mass. (Fig. 1). The strandings began about mid-October, were heavy through much of November, and tapered off in early December. The great majority of the strandings occurred along the eastern and southeastern shores of Cape Cod Bay, from Provincetown to Dennis, Mass. (Fig. 1). This is a shallow part of the Bay, with sandy bottom and wide tide flats. Local residents informed us that the stranding squid swam directly to the shore and beached themselves or were stranded by the ebbing tide. When tossed back into the water the squid immediately swam back to the beach. Our many visits to the stranding areas from mid-November to early December confirmed these observations. From all accounts, the strandings came in waves, with many thousands or hundreds of thousands of squid stranding on one day and perhaps a few on the next.

Herring gulls and great black-backed gulls were present in large numbers and were actively feeding on the squid. They showed a preference for freshly beached squid, and when the squid were abundant they ignored those that had been on the beach for a day or two. The latter were eaten when freshly beached squid were in short supply. The gulls frequently ate only the head, tentacles, and internal parts of the squid, leaving the mantles. Mantles were eaten also on those days when few squid were stranded, and it is unlikely that many of these remained on the beaches for more than a few days.

We also saw crows near stranded squid on a few occasions, and it is likely that they also consumed some of the squid.

Aerial observations, which we made in November, showed that the squid on the beaches had a patchy distribution (Figs. 3-7). On some beaches there was only a thin line of them at the high tide mark, and on others there frequently were large patches, particularly in the Eastham and Wellfleet areas. In some cases the patches apparently resulted from wind and tide concentrating the dead squid along the sides of jetties and groins. In such patches there sometimes were many thousands of squid, often lying two and three deep on the beach.

[1]Pers. commun. from C. C. Lu, Memorial University of Newfoundland, St. John's, Newfoundland, Canada, and from A. C. Kohler, Fisheries Research Board of Canada, St. Andrews, New Brunswick, Canada.

In one medium-sized patch that we measured we estimated that there were 50,000-75,000 dead squid, most of which were mantles only. Other, smaller concentrations were seen in some tidal marshes, where squid had been caught up in the marsh grass.

While the numbers of stranding squid had dropped greatly by the end of November, a few still were being reported as late as the second week in December. Small strandings may have taken place later than this, but large amounts of ice along the eastern shore of Cape Cod Bay then made observations difficult. As mentioned earlier, the commercial catch of this squid was down by late November, and so the number of squid in the Bay probably had been greatly reduced through strandings, fishing mortality, and migration to offshore grounds.

During one aircraft flight we checked a stretch of beach on the seaward side of Cape Cod, from Wellfleet to Provincetown (Fig. 1), and saw no stranded squid. We did have one report of a few beached squid being seen on the seaward side of Orleans, however, so apparently some limited stranding occurred there. Also, there were a few squid reported on the beach on the western side of Cape Cod Bay in November. In addition, a few were reported on Buzzards Bay beaches, near the western end of the Cape Cod Canal, which connects Buzzards Bay and Cape Cod Bay, in early December. These latter probably were swept from Cape Cod Bay through the canal by the strong tidal currents there. Despite these instances, however, all reports and our own observations indicate that the vast majority of strandings occurred in eastern and southeastern Cape Cod Bay.

The size composition of beached squid was similar to that of those caught aboard the *Albatross IV* in November 1976 (Table 1). Both male and female squid were among those beached. Examinations of gonads of several individuals indicated that they were not yet sexually mature, but that development was underway. Squid of the sizes found are the adults which would spawn offshore in the following winter or early spring (Mesnil, 1977).

Figure 3.—Stranded shortfin squid on First Encounter Beach, Eastham, Mass., 17 Nov. 1976.

PAST STRANDINGS

The stranding of shortfin squid is not uncommon, and it has been reported in the past, although reasons for stranding are obscure. Bigelow (1926) reported seeing stranded squid "in windrows on the flats in August and September," on islands at the mouth of the Bay of Fundy. He stated that, "for some inscrutable reason the squid, once aground, seems forced by instinct to drive farther and farther ashore—throw it out ever so often into deeper water." Verrill (1882) reported that squid of this species "often get aground on the sandflats at Provincetown, Mass., in the night," possibly when in pursuit of prey fish. He suggested that small mackerel sometimes hug the shore to escape squid and that this might sometimes bring the squid into shoals where they strand, "for when they once touch the shore they begin to pump water from their siphons with great energy, and this usually forces them farther and farther up the beach."

Table 1.—Size frequency distributions of shortfin squid in 1976 from otter trawl catches in Cape Cod and Massachusetts Bays (see Figure 1 for locations) and from samples collected on the beaches of Cape Cod Bay.

Mantle length (cm)	Number of Squid: Otter Trawl Catches, 21-22 Nov. 1976	Number of Squid: Eastham Beaches 23 Nov. to 5 Dec. 1976
18	1	—
19	2	—
20	2	—
21	15	—
22	18	2
23	26	5
24	31	9
25	53	17
26	57	17
27	50	14
28	20	5
29	7	1
Total no.	282	70
Mean length	25.1	25.5

Other strandings have been observed in the Bay through the years. None, so far as is known, was at all comparable in magnitude with the 1976 strandings, and in some cases probably involved only a few hundred or less squid. Some substantial strandings in the Dennis-Eastham area were observed by local residents in the fall of 1959 and continued into February 1960 (Prescott, 1977). Phillip Schwind of Eastham, who operated a charter fishing boat in Cape Cod Bay for many years, told us that he had seen stranding squid in small numbers from time to time. He thought that in some cases they had been driven ashore by striped bass or bluefish. So far as we know, these other strandings all have been shortfin squid.

EXAMINATION OF STRANDED SQUID

In the course of our trips to the stranding areas we collected live and freshly dead stranded squid for studies of pathogens, metal analysis, parasites,

Figure 4.—Stranded shortfin squid at the high tide line along a beach in Wellfleet, Mass., 18 Nov. 1976.

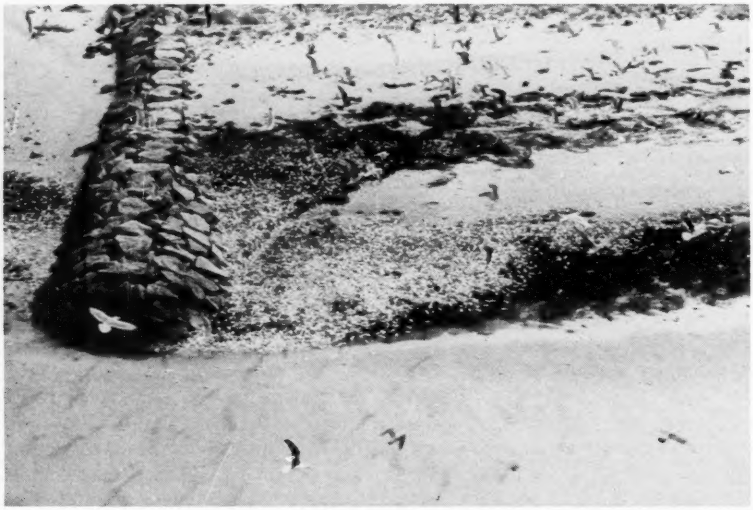

Figure 5.—Heavy concentration of stranded shortfin squid beside a groin, Eastham, Mass., 18 Nov. 1976.

and gut contents. Fred Kern, Northeast Fisheries Center, Oxford, Md., examined a sample of squid for pathogens and found no evidence of any.

Richard Greig, Northeast Fisheries Center, Milford, Conn., ran mercury and other metal analyses on samples of the squid. With the exception of cadmium and copper, which were somewhat higher in the stranded squid, the results were similar to those for the 1972-73 samples caught farther offshore. It is not known if any significance can be attached to the higher levels of cadmium and copper, since the 1976 samples (stranded squid) were based on the entire animals, compared with mantles only for the 1972-73 samples. Studies of metal content are continuing.

We examined 13 of the beached squid for parasites, and found small infestations of cestode (tapeworm) larvae in the gut of 12 of these. This is not unusual. No other parasites were found.

R. E. Bowman, Northeast Fisheries Center, Woods Hole, Mass., examined stomach contents of 19 of the stranded squid. Some of these had full stomachs, and in general, stomach fullness was about the same as that of shortfin squid from past *Albatross IV* collections so it presumably was about normal for this species[2]. Fish remains was the principal food in the stranded squid, about 95 percent by volume, with sand lance, *Ammodytes americanus,* making up most of this portion. Other fish present in the stomachs may have been cunners, *Tautogolabrus adspersus,* and butterfish, *Peprilus triacanthus,* but this is tentative. Fish identification was based on scales, since the food in stomachs is finely chopped. Squid parts were found in a few of the stomachs, which is not unusual since squid are cannibalistic.

George King of Sea Land Aquarium in Brewster, Mass. (just to the east of Dennis), told us that he put some of the live, stranded squid into aquarium tanks there when the water temperature was about 3°C. Some of these lived for up to 2 weeks. He did not see the squid feed, although he had put food (live mummichogs, *Fundulus heteroclitus*) into the tanks. Charles Wheeler, Northeast Fisheries Center Aquarium, Woods Hole, Mass., told us that 2 weeks is about as long as he has been able to keep longfin squid alive in tanks if they do not feed. He has had no experience with shortfin squid.

Water temperature records for the Cape Cod Bay end of the Cape Cod Canal showed that temperatures there in the late fall of 1976 were colder than normal, but not extremely so. The mean temperatures in October and

[2]Bowman, R. E., Food habits of fish and squid found in the vicinity of the *Argo Merchant* oil spill, August 1977. Lab. Ref. 77-18, Sept. 1977, Northeast Fisheries Center, Woods Hole, MA 02543.

November 1976 were 14.0°C, and 8.3°C, respectively. The 10-year mean (1966-75) for these months was 13.9° and 9.8°.

It may be that late in 1976, when shore waters dropped to near the freezing point, some of the squid suffered temperature shock when approaching the cold water near shore. On 4 December 1976, when we were at a Dennis beach a few squid were stranding. The water temperature there was −1.4°C. Some of the squid were swimming ashore, up near the surface, and appeared to be in good condition, although slow moving because of the cold. Other squid coming ashore were rolling in along the bottom with the waves and quite clearly were near death.

Figure 6.—A heavy concentration of stranded shortfin squid on an Eastham, Mass., beach, 18 Nov. 1976.

ESTIMATE OF NUMBERS STRANDED

To estimate the extent of strandings, we made two aircraft flights over the stranding areas: one on 18 November 1976, aboard a chartered fixed-wing aircraft, and one on 19 November 1976, aboard a U.S. Coast Guard helicopter. In the course of the flights we covered the Cape Cod Bay shore area from Barnstable Harbor to Provincetown, made relative abundance notes of beached squid on charts of the area, and made a photo record of squid distribution on beaches and in the water at shore edges. The helicopter flight included a touch-down to measure a patch of stranded squid.

Figure 7.—Stranded shortfin squid in a tidal marsh, Wellfleet, Mass., 19 Nov. 1976.

It is difficult to quantify the stranding mortality of squid over the period of strandings because of the very limited observations, the patchy distribution of squid, and the continuous loss of squid to gulls and, possibly, to other animals. However, we made an estimate of 1.25 million dead squid present on beaches and in the water at shore edge on 18 November from flight notes, photographs, and subsequent patch measurements on the ground. Considering that heavy strandings were reported over a period of a month, and that stranded squid were regularly eaten by birds, it seems likely that a total of at least 10 million squid stranded.

The mean mantle length of stranded squid was about 25.5 cm (Table 1), and the mean weight for this length was about 340 g. Ten million squid, therefore, would weigh about 3,400 metric tons.

SOME POSSIBLE REASONS FOR THE STRANDINGS

Reasons for the strandings remain unknown. In view of what is reported above, however, concerning the stranding habits of this squid, their high level of abundance in 1976, the lack of pathological findings, that stranded squid were kept alive in tanks for some period, and that the stranding squid were feeding, it appears that the strandings occurred in a natural environmental setting rather than in an environment

stressed by man's impact. The principal impacts in Cape Cod Bay, a relatively unstressed area, are waste heat from a power plant in the Cape Cod Canal and one near Plymouth, and entrainment of marine animals (largely plankton) in water used for cooling at these plants. There is no evidence that these plants are a significant factor in the temperature regime of Cape Cod Bay as a whole.

Regarding natural conditions that might have caused the strandings, one can do little more than speculate at this point. Some of our speculations follow.

We had earlier considered the possibility that the unusually rapid drop in fall temperatures played a direct role in stranding by inducing temperature shock. As noted earlier here, however, strandings already were occurring in mid-October when water temperatures still were mild. It, therefore, does not appear that temperature was the direct cause of strandings, although we do not think one can completely rule it out as a factor.

Another possible cause might relate to fall entrapment within Cape Cod Bay. There were exceptionally large numbers of this squid in 1976 and they still were abundant in Cape Cod Bay in late November, a time when this species generally is moving offshore for the winter. (Figure 1 shows abundance to have been a good deal higher in Cape Cod Bay than in Massachusetts Bay then.) The geography of Cape Cod Bay is such that it can serve as a trap to many warm-water fish and animals which might move into it in the summer. Some of these apparently fail to exit at autumnal cooling. Some animals may become disoriented or helpless when sufficiently chilled and strand. This apparently is the case with ocean sunfish and a few kinds of sea turtles which commonly strand there in the fall. In the case of squid, disorientation through failure to find exit from the Bay possibly influenced stranding.

As noted, this squid normally moves offshore in the fall and spends the winter in deeper, and warmer, waters off the outer shelf edge and possibly beyond. It begins to arrive on offshore grounds in some numbers in October. This fall migration leads the squid to move in easterly and southerly directions, with movement being triggered by declining water temperatures and perhaps other factors. The stranding squid were moving in these directions. Possibly they were attempting to migrate to offshore areas and were stopped by the barrier formed by outer Cape Cod.

The squid apparently were feeding not long before stranding, for many of their stomachs were full of freshly ingested food which consisted largely of sand lance. It appears possible that the squid might have been pursuing these small fish, a common species of sandy bottoms, became disoriented in the shallow water, and stranded. The feeding on sand lance may have increased in the fall, when some other prey species, such as mackerel, had left the Bay.

It should be mentioned, too, that the prevailing winds of the region are westerlies (southwest, west, and northwest) in the fall and winter. The winds, therefore, were blowing against the shores where the strandings occurred. The fall of 1976 was a particularly windy one, with frequent cold and strong northwest winds. These winds may have been a factor in the strandings, especially after the squid got into shallow water.

It was reported that bluefish, pilot whales, and some larger whales had been seen in Cape Cod Bay during part of the strandings. Some residents of the Bay area thought that the squid might have been driven ashore by these. Bluefish and pilot whales, and also striped bass, prey extensively on squid, and small groups of squid may have been driven ashore by them. It seems unlikely, however, that the massive strandings observed could have resulted from this. Also, it seems that strandings would have occurred in other areas than the one side of the Bay if the squid were driven ashore. In addition, it is unlikely that any large numbers of bluefish or striped bass remained in the Bay after about mid-November, since they move south with declining fall temperatures. The marine mammal report of *Albatross IV* 21-22 November 1976 gave no whale sightings in Cape Cod Bay then, although some were seen outside of the Bay around Stellwagen Bank.

Other theories may evolve from these studies. In the course of looking into the strandings we have established quite a few contacts in the Cape Cod Bay area who will alert us to further squid strandings. The Cape Cod National Seashore personnel, through regular patrols and from information sent in by local residents, maintain good records of strandings. We hope to gather more information on squid behavior and strandings in the future. Perhaps we can then more clearly define the causes of strandings.

ACKNOWLEDGMENTS

The authors are indebted to the many people who so willingly supplied information for this paper.

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Eleven Appointed to Commerce Department Marine Fisheries Advisory Committee

Secretary of Commerce Juanita M. Kreps has announced 11 appointments to the Department's top level Marine Fisheries Advisory Committee. The Committee advises the Secretary on programs carried out by the National Oceanic and Atmospheric Administration.

Topics of concern to the Committee include international fisheries, conservation, aquaculture, biological and environmental research, fisheries technology, certain sections of the Marine Mammal Protection Act of 1972, and advisory services for marine recreational and commercial fisheries.

Members of the Committee are chosen for recognized competence and proven interest in the marine fishery resources of the United States and are appointed by the Secretary for a term of 3 years. Approximately one-third of the Committee members are selected each year to achieve both balanced geographical representation as well as a broad view of the U.S. commercial fishing industry, marine recreational fishing, the academic community, conservation interests, State governments, and the consumer.

The new members are: Henry J. Cofer, Jr., President, Rich-Sea Pak Corporation, St. Simons Island, Ga.; Charles H. W. Foster, Dean, School of Forestry and Environmental Studies, Yale University, New Haven, Conn.; William C. Lunsford, Jr., Assistant Secretary, Zapata Haynie Corp., Towson, Md.; Fred Maly, Outdoor Editor, San Antonio Light, San Antonio, Tex.; Edward P. Manary, Manager, Washington State Commercial Passenger Fishing Vessel Association, Olympia, Wash.

Also named were Stephen B. Mathews, Associate Professor, College of Fisheries, University of Washington, Seattle, Wash.; Ann McDuffie, Food Editor, *The Tampa Tribune*, Tampa, Fla.; Kathryn E. Poland, State Senator, Juneau, Alaska; Haakon Ragde, Seattle, Wash., a practicing physician; Dorothy F. Soule, Director, Harbors Environmental Project, Allan Hancock Foundation, University of Southern California, Los Angeles, Calif.; Christopher M. Weld, Sullivan & Worcester, attorneys, Boston, Mass.

Other members of the Committee are: Richard B. Allen, Westport, Mass.; Edward Chin, Director, Marine Resources Program, and Director, Sea Grant Program, University of Georgia, Athens; E. Charles Fullerton, Director, California Department of Fish and Game, Sacramento; Ronald R. Jensen, Chairman of the Board and President, Pan-Alaska Fisheries, Inc., Seattle, Wash.; Joe R. Lee, President, Red Lobster Inns, Orlando, Fla.; Edward G. McCoy, Morehead City, N.C., Director, Division of Marine Fisheries for North Carolina; Guy R. McMinds, Director, Quinault Resource Development Program, Taholah, Wash.; Frank T. Moss, New York City, Associate Editor, *Yachting Magazine*, and staff member of the National Coalition for Marine Conservation; Julius R. Nelson, New Haven, Conn., President of Long Island Oyster Farms, Inc.; Mary DePoe Norris, home economist with Seattle (Washington) Power Company; Oliver A. Schulz, Manager for Fisheries Relations, Del Monte Corp., San Francisco, Calif.; Clement Tillion, Alaska State Legislator, Homer, Alaska; Claude Ver Duin, Executive Secretary, Midwest Federated Fisheries Council, Inc., Grand Haven, Mich.; Robert B. Weeden, University of Alaska, Fairbanks, Alaska; Melvin H. Wilson, Vice President and Associate Trust Council for Security Pacific National Bank, Los Angeles, Calif.; and Charles Yamamoto, President and General Manager of C&E Radio of Hawaii, Honolulu.

Clam, Oyster, Mussel Supplies Threatened

The supply of oysters, clams, and mussels available to consumers is in jeopardy, because waters that grow shellfish are inadequately protected, and because of a tangle of Federal, State, and local regulations which threaten the industry, a Commerce Department agency report claims.

The report, "The Molluscan Shellfish Industries and Water Quality—Problems and Opportunities," has been issued by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service in response to a requirement of the Coastal Zone Management Act Amendments of 1976. The law requires the Secretary of Commerce to review all aspects of the molluscan shellfish industry, including an evaluation of the impact of Federal law on water quality.

The report notes that shellfish-growing waters continue to be closed at a rate of 0.6 percent each year, although the rate for 1971-74 is one-half that of the previous 5-year period. The closures are blamed on inadequate domestic waste treatment and on urban runoff, which pollute the shellfish waters.

The fragmented nature of the industry also subjects it to many problems, according to the report. The molluscan shellfish industry consists largely of small businesses, many family owned, and most lacking mechanization. A joint government-industry revitalization program and a mechanism to address problems of overregulation are needed, the report says.

Cooperative Federal and State research is also needed to validate the criteria presently used to define "safe" harvesting areas. Present testing methods may well be restricting the use of resources that are, in fact, safe.

The report recommends that actions be taken and funding be provided to carry out programs authorized to protect shellfish-growing waters, and that Federal and State fish and wildlife agencies be given the resources they need to review permits and the effects of waste discharges. It also urges increased aquaculture and habitat rehabilitation.

The report was submitted to Congress by Secretary of Commerce Juanita M. Kreps. Copies are available from the U.S. Government Printing Office, together with support studies prepared by the National Marine Fisheries Service and the Sea Grant Universities of Delaware and Maine, with assistance from the University of Washington. The water quality study was prepared by Stanford Research Institute.

Contributing to the study were 22 shellfish producing states, 5 Federal agencies, the Shellfish Institute of North America, the National Shellfisheries Association, and the Pacific Coast Oyster Grower's Association.

Foreign Fish Vessels Off U.S. Coasts Drop to 437 in September

The number of foreign fishing and fishing support vessels sighted off U.S. coasts in September, 437, decreased slightly from the 492 sighted in August, according to preliminary figures released by the National Oceanic and Atmospheric Administration's National Marine Fisheries Service, a Commerce Department agency.

The 437 vessels sighted are also below the 514 sighted off our coasts in September of 1976. The decrease, primarily off the Atlantic Coast, is due to the 1977 prohibition on hake fishing, only 15 days fishing permitted in the squid fishery, and a vast reduction in the herring allocation over 1976 quotas. Normal seasonal decline in fishing activities and reduction in the number of foreign vessels permitted to fish within the 200-mile zone contributed to the reduction.

The foreign vessels, from eight nations, were sighted off the coasts of New England and the mid-Atlantic States, west coast, and Alaska. The largest number, 325, was from Japan, which had 322 vessels fishing for groundfish and pollock off Alaska, and 3 fishing for squid off New England and mid-Atlantic.

The Soviet Union had 66 vessels: 47 fishing for hake off the Pacific coast, 2 fishing for squid off New England and mid-Atlantic, and 17 catching pollock in Alaskan waters.

Foreign vessels sighted off the coasts in 1976 were as follows: January-420, February-510, March-435, April-560, May-924, June-970, July-842, August-543, September-514, October-452, November-258, December-240. In 1977: January-319, February-314, March-180, April-235, May-374, June-767, July-786, August-492, and September-437.

The September sightings were made by representatives of the National Marine Fisheries Service and by personnel of the U.S. Coast Guard, conducting joint fisheries enforcement patrols from Coast Guard aircraft and cutters.

A summary of foreign fishing vessels operating off U.S. coasts during September 1977 and September 1976 follows:

		No. of vessels	
Area	Nations	Sept. 1977	Sept. 1976
New England and mid-Atlantic	E. Germany	6	24
	Soviet Union	2	37
	Poland	6	7
	W. Germany	0	10
	Spain	16	23
	Japan	3	13
	Italy	1	4
	S. Korea	0	1
	Greece	0	1
	France	0	1
		34	121
West Coast	Panama	0	3
	Japan	0	1
	Soviet Union	47	38
	S. Korea	0	8
	Bulgaria	0	6
	Poland	3	9
	E. Germany	0	6
		50	71
Alaska	Japan	322	222
	S. Korea	13	54
	Taiwan	1	4
	Soviet Union	17	42
		353	322
	Total	437	514

NOAA AWARDS BUOY CONTRACT

The National Oceanic and Atmospheric Administration has awarded a contract to Polar Research Laboratories in California to design and fabricate a set of drifting buoys which will gather information on ocean currents as part of a large federal and university-sponsored research experiment in the North Pacific.

The $53,200 contract was let to the Santa Barbara, Calif., firm by the Commerce Department agency's Environmental Research Laboratories of Boulder, Colo.

Scientists from the Physical Oceanography Laboratory (part of NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla.) plan to deploy 14 of the buoys in the open ocean between Hawaii and Tahiti as a part of the equatorial program of the North Pacific Experiment (NORPAX) in November and an additional seven in January. NORPAX is funded by the National Science Foundation and the Office of Naval Research.

As each of the buoys drifts along, an electronics package mounted inside will automatically transmit its position to the National Aeronautics and Space Administration's experimental Nimbus-6 satellite orbiting overhead. NOAA scientists will receive geographic position reports from the satellite for tracking the meandering and elusive currents.

The buoys will aid scientists in the long-range goals of NORPAX: to understand fluctuations in the upper layers of the Pacific Ocean and to determine the relationship of oceanographic fluctuations to the overlying and adjoining atmosphere.

RV *Townsend Cromwell* Continues Resource Assessment in Northwestern Hawaiian Islands

The NOAA vessel *Townsend Cromwell* returned to her home port in Honolulu in early November after 2 months in the waters of the northwestern Hawaiian Islands. Fishery scientists on board the research ship were continuing a survey and assessment of the living resources of that little known area begun in October 1976 and planned as part of an intensive 5-year cooperative effort with the State of Hawaii and the U.S. Fish and Wildlife Service. The *Cromwell* is operated by the National Ocean Survey and presently attached to the NMFS Southwest Fisheries Center's Honolulu Laboratory.

Using lobster and fish traps as sampling tools, scientists aboard the *Cromwell* found relatively high densities of spiny lobsters along the southern edge of the bank at Necker Island, and also at Maro Reef, Laysan Island, and Raita Bank.

Catch rates as high as 6.9 lobsters per trap were found at Necker and, according to Chief Scientist Richard N. Uchida, only 31 percent of the lobsters caught there were "shorts" or under the legal limit of 1 pound. Many of the "legals" and all of the "shorts" taken during the cruise were tagged and released at the place of capture. When recaptured, tagged animals can provide information on growth and movement.

In the fish catches made at Middle Bank, Nihoa, and Penguin Bank was a notable abundance of "taape" or blueline snappers, introduced into Hawaiian waters from Tahiti in 1955 by the Hawaii Division of Fish and Game.

Handline fishing was excellent along the 70-120 fathom contour around some of the islands and banks, said Uchida. Snappers, including such commercially valuable species as ehu and kalikali, were plentiful around Nihoa and Necker Islands. Other commercially important fishes such as thick-lip ulua, hapuupuu, and opakapaka were abundant around Maro Reef and French Frigate Shoals. Kahala also occurred in considerable numbers at some of the areas fished by the *Cromwell*.

Trolling produced some good catches of kawakawa, ahi, and ono, particularly at Nihoa, Raita Bank, Laysan, and Maro Reef. However, trawling for bottom fish using a Norwegian fish trawl was generally unproductive. The *Cromwell* was scheduled to continue the resource assessment survey of the northwestern Hawaiian Islands early this year.

Coastal Zone Planning Symposium Is Scheduled

"Coastal Zone '78," a national symposium on the technical, environmental, and socio-economic aspects of coastal zone planning and management, will be held 14-16 March 1978, in San Francisco, Calif., the National Oceanic and Atmospheric Administration's Office of Coastal Zone Management has announced. The Commerce Department agency, with the American Society of Civil Engineers and the Conservation Foundation, will sponsor the conference—at the Jack Tar Hotel—which is expected to attract more than 1,000 participants.

More than 200 papers will be presented covering topics such as "Planning and Management Considerations," "Environmental Considerations," and "Engineering and Other Technical Considerations." The conference will be preceded by a 1-day short course on the "History and Implementation of Coastal Zone Management." NOAA's National Ocean Survey, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the U.S. Bureau of Land Management, the U.S. Geological Survey, the U.S. Environmental Protection Agency, and various California State agencies are cosponsors. A list of paper titles and authors is available from J. Robert Edmisten, Executive Director, Coastal Zone '78, P.O. Box 26062, San Francisco, CA 94126.

200-Mile Limit Foreign Fishing Fees Set

A schedule of fees for 1978 to be paid by foreign vessels and foreign nations fishing within 200 nautical miles of U.S. coasts has been announced by the National Oceanic and Atmospheric Administration, a Commerce Department agency. The fees are required by the Fishery Conservation and Management Act of 1976, which extends U.S. fisheries jurisdiction to the 200-nautical-mile limit.

Permit fees will be $1.00 per gross registered ton for each foreign fishing vessel; 50 cents per gross registered ton, not to exceed $2,500 per vessel, for vessels that only process fish; and $200 per vessel for support vessels that neither catch nor process fish. Additionally, each foreign nation with fishing vessels in the zone will be charged a poundage fee of 3.5 percent of the total dockside value of fish allocated to the nation. The only change from the 1977 schedule is the use of updated fish prices as the basis for calculating the poundage fee for 1978, computed on the basis of 1976 average dockside prices.

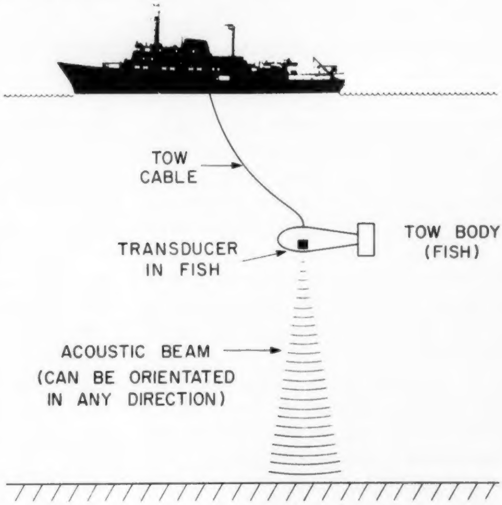
The average dockside value per metric ton follows for each species: butterfish, $622; Pacific cod, $282; Tanner crab, $441; Pacific flounders, $387; Pacific hake, $32; red hake, $185; silver hake, $184; Atlantic herring, $87; Pacific herring, $100; river herring, $96; Atlantic mackerel, $259; Atka mackerel, $138; jack mackerel, $110; other Atlantic finfish, $334; rockfish, $298; sablefish, $399; Pacific ocean perch, $280; seamount groundfish, $172; other Pacific groundfish, $48; Alaska pollock, $84; snails (meats), $600; Atlantic squid, $414; and Pacific squid, $55.

Sonar-Like System "Hears" Ocean Sediment Movement

An underwater acoustic system, similar to sonar equipment on submarines, has been developed by engineers and scientists with the National Oceanic and Atmospheric Administration (NOAA) for monitoring the movement of sediment in water. The unique system will enable scientists with the Commerce Department agency's Environmental Research Laboratories to detect and measure sediment in the water column and let them characterize, track, and map this material.

According to the NOAA scientists, the system, which is relatively portable, has broad potential for use in general oceanography, biology, chemistry, pollution research and control, and environmental impact studies. Specifically, the system can be used to study the effects of ocean and lake mining operations, dredging, the dumping of sewage sludge and other materials, and beach erosion problems.

Until now, scientists were limited in monitoring sediment transport because they could not obtain continuous measurements of the movements of the sediments in the water over a sufficient period of time, according to John R. Proni, an oceanographer with the Sea-Air Interaction Laboratory, one of NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla.



Man-made "fish" carries portions of a portable underwater acoustic system, developed by the National Oceanic and Atmospheric Administration, which can measure small amounts of sediment to within a few centimeters of the sea or lake floor. When used for tracking dredged or dumped material, the equipment would be towed behind the ship in a metal, fish-like device around the area of activity. For studying long-term events, the new device would be mounted in a fixed position on a tripod or existing structure, such as a dock, bridge, or oil rig.

Proni and Fred C. Newman developed the scientific concept, while the engineering was done by project engineer, Charles A. Lauter. The equipment includes a new feature, invented by Lauter, which he said will enable researchers to obtain information about the nature of the sediment within a "cloud" of material.

Using the acoustic system in conjunction with such conventional instruments as current meters, scientists can indicate the relationship between sediment movement and ocean currents. This information can be used to construct mathematical models for predicting what will eventually happen to lakes, harbors, river deltas, and inner continental shelf areas where sediment transport is a problem.

Fish Retail Price Index Up in August, September

The retail price index (seasonally unadjusted) for fish rose again in August by 0.7 percent over July (15.2 percent above August 1976) and in September by 2.1 percent over August according to a monthly statistical analysis by the National Marine Fisheries Service.

Of the 17 frozen and canned fishery products surveyed in August by the agency, part of the Commerce Department's National Oceanic and Atmospheric Administration, 11 increased, 4 declined, and 2 were unchanged. In September, 12 increased, 4 declined, and 1 was unchanged.

Prices increased for cod, flounder, haddock, and whiting fillets; halibut steak; king crab meat; canned chunk light tuna; canned pink salmon; canned Maine and Norway sardines; and fish portions in August, while prices decreased for ocean perch and turbot fillets, fish sticks, and breaded shrimp. Unchanged were canned solid white tuna and canned red salmon.

September prices increased for cod, flounder, haddock, turbot, and ocean perch fillets; halibut steak; canned solid white tuna; canned pink, and red salmon; canned Norway sardines; fish sticks; and fish portions. On the other hand, prices decreased for whiting fillets, king crab meat, canned chunk light tuna, and breaded shrimp. The price of canned Maine sardines was unchanged.

Compared with July, August retail fish prices increased more than did prices for poultry and meat. Retail poultry prices in August rose 0.9 percent from July, while meat prices rose less than 0.1 percent. Higher sirloin steak and cold cut prices were offset by lower chuck and round steak prices. When compared with 1976 levels, meat prices were 4.2 percent higher, and for poultry 2.8 percent higher.

Retail meat prices declined 0.7 percent in September from August, based on lower sirloin, chuck steak, loin pork chop, and liver prices. Retail poultry

prices advanced 0.4 percent in September from August, based on higher chicken prices. When compared with 1976 levels, prices for poultry were 6.1 percent higher and for meat 2.7 percent higher.

Ten cities are surveyed every month by officials of NMFS, who report prices of selected items of fish, meat, and poultry items for "Operation Fish Watch." They visit three different chain stores in each city and check the prices for the same representative brand names and types of products to determine any changes from the previous month.

The cities surveyed are: Atlanta, Ga.; Boston, Mass.; Little Rock, Ark.; Galveston, Tex.; San Francisco and Los Angeles, Calif.; Pascagoula, Miss.; St. Petersburg, Fla.; Seattle, Wash.; and Washington, D.C.

Moffatt Wins NOAA Fellowship At SWFC

Izadore Barrett, Southwest Fisheries Center Director, National Marine Fisheries Service, NOAA, La Jolla, Calif., has announced that Nancy Moffatt has received the National Research Council/National Oceanic and Atmospheric Administration Post-Doctoral Research Fellowship at the Center's La Jolla Laboratory. Moffatt, who received the Ph.D. degree in May 1977 from the University of Arizona, is the second woman to be honored with the NRC/NOAA Fellowship at the Center since its national inception in 1970.

Moffatt received her early education in San Diego and Escondido, Calif. public schools and completed the first 2 years of her college training as a biology major at the University of California, San Diego. Her interest in marine biology and ichthyology led her into graduate study at the University of Arizona. Moffatt has written six papers on the biology of the Gulf of California grunion and its close relative, the California grunion of the Pacific.

At the NMFS Southwest Fisheries Center, Moffatt is conducting a series of feeding and rearing experiments designed to verify survival and growth rates reported by earlier researchers for several larval fishes reared at extremely low food densities. Moffatt has set up 20-gallon glass aquariums into which she has introduced anchovy larvae hatched from eggs spawned in the laboratory. She has begun a series of experiments, initially feeding the tiny fish with *Chlorella*, a green algae, supplemented with wild plankton which she obtains each morning with a fine-meshed net off the Scripps pier.

Moffatt's career goal is fisheries research and university teaching at the undergraduate level.

Bowhead Whale Research and Management Planned

Formulation of an expanded research program on bowhead whales and initiation of the development of a management and conservation regime that would permit limited subsistence hunting by Eskimos have been announced by Richard A. Frank, Administrator of the National Oceanic and Atmospheric Administration.

These actions followed a mid-October decision by the Department of State that the United States government had decided not to present an objection at this time to the June action of the International Whaling Commission (IWC) removing the Alaskan Eskimo exemption for subsistence hunting for bowhead whales. In addition, the Department of State said that at a special meeting of the IWC in December the United States would work for Commission approval of a subsistence hunt by the Eskimos.

Frank indicated that the major objective now is rapid development of a sound management and conservation regime in cooperation with the Eskimo communities involved in hunting for bowheads. The Commerce Department official noted his deep concern for the welfare and culture of the Eskimos and pledged that he would personally work for IWC approval of a reasonable subsistence hunt. He added that the development of an adequate management and conservation regime would require the cooperation and efforts of other interested and affected parties—the Eskimos, the environmental community, and state governments.

NOAA also initiated contacts with the Alaska Eskimo Whaling Commission to begin discussion on the elements to be included in a management regime. Those discussions were to be continued over several weeks to prepare a proposal for the IWC on subsistence hunting based on the United States' management regime and research program.

Hussey Chairs CZM Committee

The National Coastal Zone Management Advisory Committee has elected John F. Hussey, Director of Legislative Affairs for Monsanto Company, as Chairman, Secretary of Commerce Juanita B. Kreps has announced. The Committee also elected Janet K. Adams, President of the California Coastal Alliance, as Vice-Chairman. The 11-member committee advises the Secretary of Commerce on implementation of the Coastal Zone Management Act of 1972.

Hussey formerly was Director of the Senate National Ocean Policy Study, and has had extensive experience with coastal zone and related legislation during his 10 years in various staff positions on Capitol Hill. Primary role of the Committee is to act as an independent advisor with respect to activities of the Office of Coastal Zone Management, part of the Commerce Department's National Oceanic and Atmospheric Administration.

Hussey has indicated that the Committee plans to initiate immediate effort, through Committee task groups, to obtain a "grassroots" assessment of the program, and to determine the extent to which the program, designed by Congress in 1972, is meeting today's coastal zone problems and conflicts. The Committee represents industry, environmental, and public interest groups. It addresses energy exploration, development and facility siting; housing; recreation; environmental protection; economic development; and other policy issues affecting the Nation's ocean and Great Lakes coastal regions.

NOAA Current-Sensing Radar Helps Monitor Marine Oil Pollution

A current-sensing radar developed by the National Oceanic and Atmospheric Administration (NOAA) may become a major tool for monitoring sea pollutants and setting environmental baselines where petroleum and other explorations are planned. The radar permits monitoring of surface currents up to 50 miles and enables production of current-movement computer maps over 750 square miles every half hour, according to NOAA scientists.

Developed by Commerce Department scientists with NOAA's Wave Propagation Laboratory in Boulder, Colo., the new radar system could provide an effective alternative to surface drifters, drogues, and other ocean current determination methods now used that measure water motion only at a single point.

In the 12 October issue of *Science*, Donald Barrick, who leads the ocean remote sensing effort at the Boulder laboratory, and his co-workers described the results of recent tests of the experimental system conducted from southern Florida's east coast with the aid of Nova University. Subsequent tests last summer in Alaska's Cook Inlet, noted for its large tidal currents and the proposed site of offshore petroleum development, largely confirmed the Florida results.

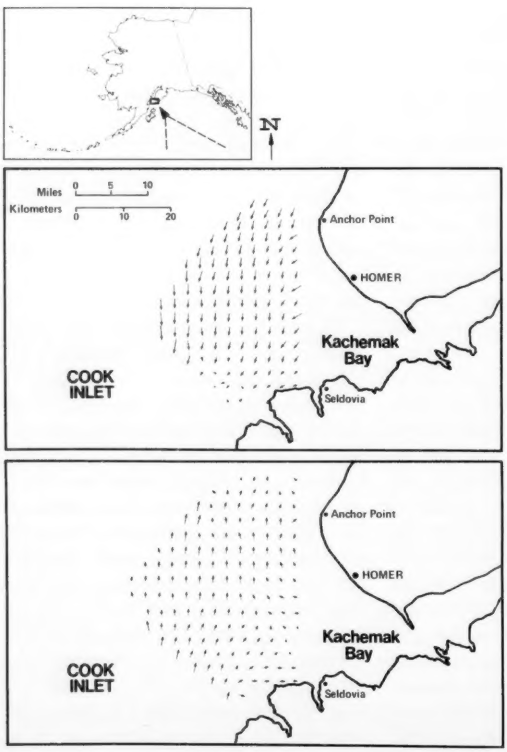
According to Barrick, the Alaska results showed that " . . . we can produce a single current-vector map covering thousands of square kilometers after only 15 minutes of operation; we can gather at least a thousand times more data in a given twelve-hour period than any alternative technique; and our system error is at worst half a knot of current velocity, and probably much better."

The experimental system is a pair of transportable, high-frequency pulsed radars, each controlled by a minicomputer. Echoes from the sea surface at points about 2 miles (3 km) apart on an imaginary grid are received by two sets of antennae. The antenna frames are placed on the beach near the waterline, where wet sand grounds them and helps push their signals out beyond the horizon over the ocean's electrically conductive surface. Conventional over-the-horizon radar requires a signal-relaying bounce off the ionosphere to move the pulses out beyond a line of sight.

The radar-controlling minicomputer processes the signals and current data while the system is operating and draws a map of the surface current velocity at each grid point, clearly showing the speed and direction of surface currents over the area scanned.

NOAA's new radar system deduces ocean current velocity by sensing the scattering of radar echoes by ocean waves. The underlying principle of the system was first demonstrated experimentally by Douglass Crombie, now director of the Commerce Department's Institute for Telecommunications Science in Boulder. Nearly a decade later, in the mid-1960's, the observed phenomenon was confirmed theoretically by Barrick, in what is considered a breakthrough in wave propagation theory.

Support for developing and testing the prototype current-sensing radar has come from the Coast Guard, Energy Research and Development Administration, and, through NOAA's Outer Continental Shelf Environmental Assessment Program, from the Interior Department's Bureau of Land Management.



A novel radar system developed by scientists with the National Oceanic and Atmospheric Administration produced these maps of water movements in Alaska's Cook Inlet at two different times on 1 July. A pair of transportable, high-frequency antennas stationed on the coast can sense ocean currents up to 50 miles (80 km) from shore to generate computer-drawn maps of current movements over 750 square miles (2,000 km^2) every half hour. The newly developed radar, also tested on southern Florida's east coast, could help monitor the trajectories of spilled oil or other pollutants. The radar was developed by scientists with the Commerce Department agency's Environmental Research Laboratories.

Fish Product Export Market Study Slated

The Department of Commerce will fund a study to identify domestic and foreign markets for fish and shellfish found within the U.S. 200-mile conservation zone and in the Great Lakes but not fully used by U.S. fishermen, Secretary Juanita M. Kreps has announced. The study also will determine the finan-

cial, technological, and institutional barriers to the development of these resources in the United States.

"We are harvesting about 2.8 billion pounds of edible seafood now and have the opportunity to catch 24 billion pounds," she said. "The Fishery Conservation and Management Act provides us an excellent export potential since almost the entire catch being made by foreign vessels in the 200-mile zone is consumed abroad. It would be reasonable to assume we can win a significant share of their seafood market."

The study will determine marketing opportunities and provide specific information on market structures, product packaging, and labeling requirements, as well as identifying tariff and nontariff barriers of 15 major fish and shellfish consuming nations in Western Europe and the Far East. In addition, the study will consider the feasibility of establishing an Export Market News Service to provide current market information in major foreign markets. An assessment of the domestic market requirements over the next 10 years also will be made and evaluated in light of the resources available to U.S. fishermen.

After the opportunities in the domestic and foreign markets are defined, an analysis will be made of the current status of domestic harvesting and processing capabilities, including legal and institutional barriers that inhibit productivity, increase costs, and limit opportunities for growth.

The study will be funded by these Commerce agencies: NOAA's National Marine Fisheries Service and the Office of Sea Grant; the Economic Development Administration; the Coastal Plains Regional Commission, New England Regional Commission, Pacific Northwest Regional Commission, and the Upper Great Lakes Regional Commission.

Marine Oil Pollution Study Contracts Let

The National Oceanic and Atmospheric Administration has awarded contracts totaling $125,822 to three research facilities to make studies of the effects of oil spills on certain birds and mammals which inhabit the west coast, and on the vulnerable salt marshes, tidal flats, and beaches of the Beaufort Sea coast of the Arctic Ocean. The awards were made to the University of South Carolina, the University of California at San Diego, and the Point Reyes Bird Observatory at Stinson Beach, Calif.

The contracts are part of a major marine environmental study conducted by the Commerce Department agency's Environmental Research Laboratories for the Interior Department's Bureau of Land Management as part of its Outer Continental Shelf Environmental Assessment Program. These studies seek to determine the probable ecological impacts of oil exploration and development activities on Alaska's outer continental shelf.

Scientists at the University of California's Scripps Institution of Oceanography and its Physiological Research Laboratory in La Jolla were awarded $59,088 to study the effects of oil contamination on the fur of sea otters. Results of the research will be compared with data from current studies on northern fur seals and other fur-bearing species.

Ornithologists at the Point Reyes Bird Observatory were awarded $27,234 to make an in-depth study of the influence of petroleum on egg formation and embryonic development among Cassin's auklets which inhabit the Farallon Islands 20 miles west of San Francisco. These small gray birds are representative of the many birds breeding along the Pacific coast that are at risk from oil pollution during their reproductive period.

As part of ongoing research, scientists from the University of South Carolina's Department of Geology received $39,500 in supplemental funds to continue work on the oil spill vulnerability of the Beaufort Sea coast. Results of their work will include maps of the comparative vulnerability of the entire coastal zone between Point Barrow and Demarcation Point, which is near the eastern border of Alaska and Canada. The University scientists will also produce a general environmental geologic map—a basic inventory of the surface geology in terms of resource utilization and preservation—of the Beaufort Sea coast. NOAA has awarded a total of $183,643 to the University of South Carolina for this study during the past 2 years.

OCEANLAB CONTRACT AWARDED BY NOAA

A $1.167 million contract for defining the physical characteristics of the planned OCEANLAB mobile underwater laboratory has been awarded to the Re-entry and Environmental Systems Division of the General Electric Co.[1], Philadelphia, Pa., the National Oceanic and Atmospheric Administration (NOAA) has announced. The 11-month contract will provide preliminary specifications for the OCEANLAB system, as well as program plans for subsequent phases.

NOAA, a Commerce Department agency, is establishing mission and performance requirements on which the final system configuration and specifications will be developed by the contractor. NOAA's Office of Ocean Engineering, through its Manned Undersea Science and Technology program, is carrying out the project.

General Electric has formed an OCEANLAB team with Perry Oceanographics, Inc., Riviera Beach, Fla., and M. Rosenblatt and Son, Inc., Arlington, Va. GE and Perry conducted a preliminary study of the system for NOAA, which was completed in December 1976.

OCEANLAB will provide the United States with a capability for advanced underwater scientific research and exploration during the 1980's. Its mission capabilities will help scientists and engineers meet growing needs to develop and use offshore oil, gas, mineral, and fishery resources, and conduct research to better understand and protect the ocean environment. The system will be equipped with laboratory facilities to provide occupants with comprehensive research capabilities.

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

The Market for Eels in the Federal Republic of Germany

INTRODUCTION

The Federal Republic of Germany (FRG) has traditionally been the largest European market for the European eel, *Anguilla anguilla,* and has depended heavily on imports from northern European suppliers, chiefly Denmark. In recent years, though, static eel production in the Baltic Sea has permitted Canada, the United States, and New Zealand to increase their exports of other eel varieties to the FRG to meet rising demand.

The U.S. share of eel exports to the FRG increased to 8.5 percent of the total in 1976, and although the volume was still under 400 metric tons, the value was over $1 million. Despite the intricacies and strict quality requirements of the international eel trade, current projections point to rising U.S. sales of the American eel, *Anguilla rostrata*, to the FRG and other European countries in the years ahead.

DOMESTIC PRODUCTION

Figures on eel production are imprecise in most countries, and the FRG is no exception. The FRG eel catch from inland rivers, lakes, and ponds has been estimated at about 1,000 t annually for some years. The number of sport fishermen has increased, though, in recent years, and since their catches are not registered, the above figure is at best only a rough estimate. On the other hand, the FRG's catch of marine eels has declined. The marine eels are caught by fishermen operating trawlers in the estuaries of rivers flowing into the North and Baltic Seas. Although there was some increase in the North Sea eel catch after the middle 1960's when trawlers began to be used, this fishery has probably stabilized recently. The eel fishery in the Baltic has been declining since the late 1960's. The Food and Agriculture Organization (FAO) of the United Nations gives the following figures for the FRG's eel catch (in metric tons) in the North Sea and the Baltic from 1970:

FRG eel catch in the North and Baltic Seas.

Year	Catch	Year	Catch
1970	500t	1973	400
1971	500	1974	351
1972	400	1975	382

CONSUMPTION AND PRICES

West Germany is the largest market in Europe for eels and domestic consumption is estimated at about 6,000 t annually. Moderate increases in future eel consumption are probable. Most of the eels consumed in the FRG, estimated at from 80 to over 90 percent, are smoked, with the large part of the rest processed into jellied eels.

Eel prices in the FRG vary widely according to the type of eel, quality, and weight. Generally, they tend to be highest in November and December, resulting from high Christmas season demand, and lowest in the summer and fall months. Prices at the retail level for smoked eels are about $8.00 per pound, but these are normally the highest quality eels, fairly large in size and with above-average fat content.

At the ex-vessel level, prices are much more difficult to determine, mainly because they differ so much according to the various types of eels imported into the FRG. The average ex-vessel price for eels imported from the United States in 1976 was $1.55 per pound for fresh or refrigerated eels, and $1.10 per pound for frozen eels. According to German sources, current prices for U.S. eels have not changed much from 1976. This price range, however, is for the American eel and the Australian eel, *Anguilla australis*. Recent ex-vessel prices in Denmark and Italy for the preferred European eel suggest an average range of from $2.00 to $2.75 per pound. In addition, among the 20 countries which exported fresh or refrigerated eels to the FRG in 1976, the average ex-vessel price for U.S. eels ranked 16th, with only New Zealand, Turkish, Canadian, and Australian eels selling for lower average prices.

IMPORTS

FRG eel imports have recently increased somewhat, and in the last 4 years they have slightly exceeded 5,000 t annually. Since most of the eels are smoked, and the German processors prefer live eels for that purpose, approximately 85 percent of the imported eels are live or refrigerated rather than frozen. It is interesting to point out, however, that over half of the U.S. eel exports to the FRG consist of frozen eels.

Figures for 1976 show that imports accounted for nearly 75 percent of the FRG's total eel supply. More than half of these imports originated from countries which supply Baltic eels, for which there is a pronounced preference in the FRG. Denmark, which provided about 40 percent of the FRG's eel imports, has been the traditional leader, followed by the Netherlands, New Zealand, Canada, the United States, Poland, and Sweden.

The difference in average prices paid to eel suppliers in 1976 was considerable (Table 1). The favorite Baltic eels were delivered at ex-vessel prices which were up to three times greater than the less-favored Australian eels from New Zealand.

QUALITY RESTRICTIONS

Sources in the industry emphasize the complicated nature of the international eel trade, especially as regards the stringent requirements for certain quality characteristics. In the FRG, where most of the eels are smoked, the

Table 1.—West German eel imports, 1976.

Country of origin	Imports (t)	Value (1,000 DM[1])	Avg. Price (DM/kg[2])
Fresh or refrigerated			
France	108.3	1,336	12.34
Belgium/Luxembourg	94.4	1,154	12.22
Netherlands	409.4	5,055	12.35
Italy	121.1	1,480	12.22
Great Britain	29.9	334	11.17
Ireland	37.0	369	9.97
Denmark	2,170.4	27,720	12.77
Sweden	218.9	2,809	12.83
Austrua	26.3	246	9.35
Spain	15.7	230	14.65
Greece	36.1	482	13.35
Turkey	18.5	141	7.62
Poland	399.4	4,961	12.42
Hungary	26.7	288	10.41
Tunisia	11.2	162	14.46
United States	179.9	1,551	8.62
Canada	169.5	1,153	6.80
Australia	94.4	675	7.15
New Zealand	232.1	908	3.91
Total	14,419.9	51,193	
Frozen			
Netherlands	62.3	334	5.36
Denmark	19.5	218	11.18
Greece	48.9	606	12.39
Turkey	22.6	166	7.35
United States	197.1	1,208	6.13
Canada	258.7	1,559	6.03
P.R. China	22.5	121	5.38
Australia	59.7	437	7.32
New Zealand	75.7	303	4.00
Total	771.1	4,999	

[1]CIF German seaport or border (excluding import duty).
[2]The average conversion rate in 1976 was US\$1.00 = DM2.53. The late-1977 rate was approximately US\$1.00 = DM2.35.

most important quality characteristic is the fat content. The minimum fat content for smoking is apparently 12 percent, although there are reports of eels being marketed with some success with as little as 8 percent fat content. In this connection, it should be noted that the mature eels, called silver eels, which are the most highly prized for smoking, have an average fat content of 27 percent. The average estimated fat content of yellow eels, those which have not yet attained sexual maturity, is the minimum 12 percent.

In both the silver and yellow categories, there is a further breakdown between broad-headed and narrow-headed eels. This feature is determined by the eating habits of the eels. The broad-headed eel (an eel turned predator) is lower in fat content than the narrow-headed eel (an eel feeding mainly on vegetable matter and plankton).

An additional complicating factor is the classification of eels by weight. Those eels which are used for cooking or frying rather than smoking are referred to as "green" eels and they should be large, usually no less than 1 pound, while those over 2 pounds are preferred. For smoking purposes the very large eels are not in great demand because the retail price would be prohibitive. Therefore, the weight classes of 0.5-1 pound and 1-2 pounds are preferred.

The bulk of eels are marketed live in the FRG. Dealers and processors are somewhat reluctant to accept frozen eels. Occasionally eels which were not promptly sold were frozen after they had begun to deteriorate and small-scale smokers were unable to handle them properly. Live eels have been flown from the United States to West Germany in flat waxed cartons, lined with plastic foil and covered with a small amount of crushed ice, which, through slow thaw, keep the eels wet.

Frozen eels are usually shipped by ocean freighters in waxed cardboard boxes usually containing about 50 pounds of eels. Within each box, smaller blocks of frozen eels are usually wrapped in plastic foil bags.

In general, industry sources tended to place American eels in the category of second grade quality for which the market in the FRG is necessarily limited. Several also pointed out that it would be a good idea for American eel exporters to provide samples in order to promote their product more successfully. They did mention, though, that if U.S. eel exporters could improve the quality of the product by offering for sale narrow-headed, silver eels, with a high fat content and fine-textured flesh, preferably in the 0.5- to 1.5-pound weight class, the market for U.S. eels in the FRG could be expanded significantly.

According to the NMFS Office of International Fisheries, West Germany is the leading consuming nation in a traditional and fairly steady European market for smoked, jellied, and fresh eels. European consumption of eels has probably been about 20,000 t per year for some time, although one observer has predicted a European market of 30,000 t annually by 1985. The major producing countries are Denmark and France, followed by the Netherlands, West Germany, and Italy. European supplies have been supplemented increasingly in recent years by imports from the United States, New Zealand, and Japan. The major marketing centers for the European eel trade are Hamburg, Copenhagen, the Ijsselmeer region in the Netherlands, and Milan.

European supplies appear to have stabilized and, therefore, the market should require increasing imports in future years. In the Baltic Sea there is little doubt that the eel stock has been declining since the early 1960's; similarly, there is evidence that French, Italian, and Spanish eel catches in the Mediterranean Sea are also decreasing. On the other hand, there is reason to believe that French and Spanish catches in the Atlantic Ocean may be increasing somewhat. Figures collected by the FAO put Europe's annual eel production between 1970 and 1975 in a narrow range of 19,000-20,000 t, except for 1972 when it dropped to only 17,300 t. It should be kept in mind, however, that all of these statistics are somewhat unreliable.

At a 1976 international conference in Helsinki on eel aquaculture and exploitation, it was suggested that practically all of the wild eels in European waters have been exploited as much as possible and that, until eel farming is further developed, supply will be insufficient to meet demand. Some evidence indicates that the local increases in eel catches come primarily from lakes and inland waters rather than from traditional maritime sources. The most thorough work on inland eel farming has to date been done by Polish marine biologists.

In response to the tightening eel supply, the European Economic Community (EEC) has taken steps recently to facilitate the importation of eels to the member-states. In 1976, the EEC twice increased the quantities of eels which could be imported to the Community without having to pay the Common Customs Tariff duty of 5 percent. The quota of imported eels which is currently exempted from the duty is 7,200 t. (Source: IFR-77/181.)

Fishery Data Printed for Chile, Barbados and Costa Rica

Reports for Barbados, Chile, and Costa Rica, listing government agencies and officials responsible for fisheries, fishing companies and commercial representatives, fishery trade journals, and information on seafood detentions, if any, have been compiled by the Office of International Fisheries, National Marine Fisheries Service, NOAA. The reports may be requested, by number, from NMFS Statistics and Market News Offices.

Barbados' fishery administration is responsible to the Ministry of Agriculture, Food, and Consumer Affairs. That address is: Permanent Secretary, Ministry of Agriculture, Food, and Consumer Affairs, Codrington, St. Michael. For the full report, request "IFR-77/182."

Responsibility for fisheries in Chile is divided between the Ministry of Agriculture and the Ministry of Economy. The government is now reportedly considering the establishment of a Ministry of Fisheries to unite all agencies responsible for fisheries into one agency.

Chile's Fisheries Protection Division is in charge of imposing fishing restrictions on species to prevent overfishing. It's address is: Division de Proteccion Pesquera, Servicio Agricola y Gandero, Ministerio de Agricultura, Casilla 4088, Santiago.

The Fisheries Division provides technical and economic assistance to fishing ccooperatives. It's address is: Division de Pesca, Instituto de Desarrollo Agropecuario, Ministerio de Agricultura, Teatinos 40, Santiago. In the Ministry of Economy the Fisheries Development Institute evaluates and implements policies concerning the utilization of Chile's fishery resources. That address is: Instituto de Fomento Pesquero, Ministerio de Economia, Pedro de Valdivia 2633, Santiago. For the full report on Chilean government and industry fishery organizations, request "IFR-77/191."

In Costa Rica, the Ministry of Agriculture's responsibility for fisheries is divided between two agencies. Dealing with marine fisheries is: Ing. Eduardo Bravo, Director, Departmento de Flora y Fauna, Ministerio de Agricultura y Ganaderia, Apartado 10094, San Jose. Responsible for aquaculture and freshwater fisheries is: Ing. Herbert Nanne, Jefe, Departmento de Acuacultura, Pesca Continental y Vida Silvestre, Ministerio de Agricultura y Ganaderia, Apartado 10094, San Jose. For the full Costa Rican report, request "IFR-77/195."

CANADA AMENDS FISHERIES ACT

Canada has amended its Fisheries Act, providing greater protection to the aquatic environment and more severe penalties. The Amendments went into effect on 1 September 1977. Federal and provincial authorities will seek industry and public support because these changes cover a broad range of activities not limited to fishing operations.

Lobster and salmon poachers take about $6.5 million annually from Canadian fishermen. With industry and public support, new provisions of the revised Fisheries Act will place the federal and provincial authorities in a much better position to deal with the poaching problem. These new provisions include:

1) Forfeiture of illegal catch and of vessels engaged in illegal fishing.

2) Restrictions on activities such as landfill or construction in coastal areas likely to harm marine habitats.

3) Broader and more flexible authority to regulate against industrial pollution of waterways; more effective regulations for the emergency pollution problem.

4) Mandatory spill reporting and clean-up.

5) Increased penalties for all pollution offenses.

6) Regulations prohibiting interference with the east coast seal hunt; access to the sealing grounds is restricted to those involved in authorized sealing activities. This measure will not bar the media, but will keep away persons intent on interfering with sealing operations.

7) An innovative amendment, termed "ticketing," obviating court appearances for minor offenses, with fines of $100 or less.

8) Granting commercial fishermen the right to initiate civil actions for loss of income caused by pollution sources other than ships.

9) Designation of fishery officers as peace officers with powers to serve summonses and warrants.

10) A new definition of "fishing" to include an attempt to catch fish as well as the actual capture.

11) Authority to extend, if necessary, the restricted area for trawlers beyond the present limit of 12 miles from shore. (Source: IFR-77/194.)

Canada Eyes Power Plant Coolant for Aquaculture

The Government of the Province of Ontario, Canada, has begun to examine the economic viability of using heat produced by the electric power generating stations of the provincially-owned utility, Ontario Hydro, as an alternative energy source for greenhouse heating and the farming of fish. The project, announced by the Provincial Energy Ministry and Agriculture and Food, and Natural Resources Ministries, involves spent coolant water from the nuclear generating station of Ontario Hydro on the Bruce Peninsula which is now fully returned to Lake Huron.

According to Ontario Minister of Energy James Taylor, it was hoped that construction of necessary facilities could begin in the spring of 1978 after the detailed economic and engineering studies are completed.

This application of spent coolant from industrial plants is apparently novel in Ontario, at least in utilization of the heat currently lost from Ontario Hydro generating facilities. However, it must be remembered that the announcement by several Ministers of the Crown was made in the middle of an election campaign and may have been given undue emphasis as a result of this fact.

Those interested in additional information on the above project may write to: Marcia Dorfman, Ministry of Energy, Ontario, Canada; Telephone (416) 965-3246. (Source: IFR-77/187.)

AFRICAN FISHERY OFFICIALS LISTED

The Branch of International Fisheries Analysis has prepared the following list of African fishery officials. The list is accurate as of 1 July 1977. Sources include U.S. Embassies in the respective countries, files in the NMFS Branch of International Fisheries Analysis, and the Office of the Regional Fisheries Attache for Africa. (From: IFR-77/183.)

Afars and Issacs
Unknown

Algeria
Zouaoui Reggam
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Office Algérien des Pêches
Ministère des Transports
1, Place de la Pêcherie
Algiers

Angola
José Carlos Victor de Carvalho
Secretary of State for Fishing
Ministry of Fisheries
Luanda

Benin
Augustin Honvou
Director des Pêches
Direction des Pêches
Ministry of Rural Development and Cooperative Action
B.P. 383
Cotonou

Botswana
Kirby Gilmore
Fisheries Officer
Division of Animal Production
Ministry of Agriculture
Private Bag 33
Gaborone

Burundi
Audace Cayabanda
Directeur
Department des Eaux et Forêts
Ministère de l'Agriculture et de l'Elevage
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Bujumbura

Cameroons
Theophile Epee-N'Goube
Directeur Général
Direction des Pêches Maritimes
Ministère de l'Elevage et des Industries Animales
B.P. 121
Douala

Cape Verde
Joao Pereira Silva
Ministro de Desenvolimento Rural
Praia

Central African Empire
Alphonse Catchy-N'Gakoudou
Directeur Général
Direction des Eaux, Pêches et Pisciculture
Ministère de l'Agriculture des Eaux, Forêts, Chasses, Pêches, et Tourisme
B.P. 786
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Chad
Lassou Kourdina
Director of Water and Fishing
Ministry of Tourism, Handicrafts, and Natural Resources
N'Djamena

Comoro Islands
Unknown

Congo
Directeur Général
Service de la Conservation de la Nature et des Chasses
Direction des Eaux et Forêts
Ministère de l'Agriculture, de l'Elevage, du Genie Rural, et des Eaux et Forêts
Brazzaville

Egypt
Abdel Aziz Hussein
Minister of State for Agriculture and Cooperative Cos., Aquatic Wealth and Sudan Affairs,
Ministry of Agriculture
Land Reform and Reclamation Bldg.
Sharis Wezaret El Zeraa', Dokki
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Equatorial Guinea
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Guinea-Bissau
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Ivory Coast
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Secretary
Secretariat of Nutrition and Sea Wealth
Shara al-Jumhuriyya, P.O. Box 315
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Madagascar
Andrianirina Ralison
Chef
Servicede la Pêche Maritime
Direction de l'Elevage et de la Pêche Maritime
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Male

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Director
Operation Pêche
Mopti

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Minister
Ministry of Fisheries and Merchant Marine
Nouakchott

Mauritius
Iswardeo Seetaram
Minister of Fisheries
Ministry of Fisheries
Port Louis

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Caixa Postal 1723
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Reunion Unknown

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St. Helena
Unknown

Sao Tome and Principe
Unknown

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Ministry of Fisheries and Sea Transport
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Directeur de la Pêche et de la Pisciculture
Ministère du Tourism et de l'Environnement
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Kasela Bin Kembolo
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Soviet and U.S., English Joint Ventures Reported

The Soviet Union, Poland, and East Germany have received permission from the European Economic Community (EEC) and the British Ministry of Agriculture, Fisheries, and Food to operate a fleet of factory vessels on the Cornish mackerel grounds in cooperation with Joint Trawlers International, a British fishing company. Four factory vessels from the three East European countries were expected to participate initially in the cooperative arrangement during the winter mackerel season. The factory vessels purchase mackerel caught by British fishermen, process the fish at sea, and either ship the processed fish to eastern European markets or sell it internationally. Some of the fish could ultimately be bought back by Joint Trawlers and re-exported to non-EEC countries.

In late July and early August 1977, a trial run was conducted with the Soviet factory vessel *Rybak Latvii* (13,500 GRT, B-69 class) off Ayr on the west coast of Scotland. The *Rybak Latvii*, which was anchored several miles off shore, was buying up mackerel as quickly as it could be caught, according to British press reports. In the course of a few weeks, the Soviets purchased about 400 t of mackerel from Scottish fishermen and paid them considerably more than the prevailing United Kingdom ex-vessel price. The joint operation gave a welcome boost to Scottish fishermen whose activities have been restricted by a ban on herring fishing in the North Sea and lowered herring quotas off western Scotland and in the Irish Sea. The *Rybak Latvii* was expected to move on to the Minches, the waters between the Scottish mainland and the Outer Hebrides.

The Managing Director of Joint Trawlers, Jon Carrol, has indicated that his firm will be following a policy of buying from local Cornish fishermen first when the mackerel fishery began. However, because each eastern European factory vessel is capable of freezing 120 t/day, he said he also expected to make arrangements with Scottish and Humberside fishing companies and/or fishermen to supply mackerel to the other factory vessels that were to arrive. If this joint mackerel operation proves successful, Joint Trawlers may try a similar one for the sprat fishery off the northeast coast of Scotland.

According to the NMFS Office of International Fisheries, the Soviet Union has also formed a joint venture with a U.S. company, the Bellingham Cold Storage Company in Washington State, to participate in fisheries for Pacific hake and Alaska pollock in the northeast Pacific. In July 1976, the joint venture, called the Marine Resources Co., was incorporated in Washington State following 3 years of planning and discussions between the partners. The capital stock in the company is held equally by Bellingham Cold Storage and SOVRYBFLOT, an organization under the Soviet Ministry of Fisheries responsible for arranging international joint ventures. The Marine Resources Co. currently has offices in Seattle and Bellingham, Wash. Another office was to be opened soon in Nakhodka, one of the main Soviet fishing ports on the Siberian Pacific coast.

The joint venture corporation will purchase hake and pollock from U.S. fishermen for delivery to a Soviet vessel and processing at sea. Ownership of the factory vessel will remain with the Soviet Ministry of Fisheries which will be responsible for its operation. The finished product, which will be owned by the corporation, will be sold on the international market. Besides joint fishing activities, the Marine Resources Co. also plans to become involved in arranging the repairs of Soviet vessels, marketing Soviet fishery products, and providing the Soviet fishing fleet with perishable foodstuffs, water, and fishing gear.

The Soviet Union has already outfitted a factory vessel, the *Sulak* (19,000 GRT, SPASSK class), with West German (Baader[1]) processing equipment for the production of frozen hake and pollock blocks from the U.S.-caught fish. The joint corporation had planned to process hake aboard the *Sulak* on an experimental basis in the summer of 1977. However, the *Sulak* was not issued a permit to operate in the U.S. 200-mile fisheries zone in conjunction with the joint venture. The permit was denied pending the development of a national joint venture policy. It was considered preferable to wait for the outcome of National Marine Fisheries Service and Congressional hearings on joint ventures rather than to set a precedent before the full range of consequences of decisions on joint fishing arrangements between U.S. and foreign interests had been examined. The Marine Resources Co. planned to submit a permit application for the *Sulak* for the 1978 hake and pollock seasons. (Source: IFR-77/193.)

[1]Mention of trade names or commercial firms does not imply endorsement by the National Marine Fisheries Service, NOAA.

An FRG Oyster Market Report

The U.S. Consulate General in Bremen has prepared a 4-page report on the market for oysters in the Federal Republic of Germany (FRG). The report is based on FRG Government statistical records and consultations with several leading firms in the FRG oyster trade. It discusses in detail FRG oyster production, imports, customs duties; it also includes a translation of the FRG law governing quality control standards for imported seafood products and two tables on FRG oyster imports. In addition there is a list of eight FRG firms with addresses and telephone numbers interested in importing oysters.

U.S. companies wishing to receive a copy of the report should send a preaddressed mailing label with their request to: Matteo J. Milazzo, Foreign Affairs Specialist (F411), Office of International Fisheries, NMFS, NOAA, U.S. Department of Commerce, Washington, DC 20235. (Source: IFR-77/185.)

Gambia Nabs Poachers; Seychelles, Mauritius Approve New EEZ Laws

The Gambian government took action last year to gain further control of the fishing industry and foreign fishing off its coast. The most significant action was an effort to control poaching by fishing vessels of other countries. The procurement of the *SeaDog*, a British-made patrol boat, and its maiden voyage apprehension of a Polish trawler fishing illegally in Gambian waters made great publicity and paid, in one fell swoop, the cost of purchasing the patrol boat. In September 1977 the *SeaDog* again made an impressive haul by nabbing two South Korean fishing vessels and bringing them into harbor, where they lay at anchor for all to see. The crews were arrested, tried, and fined. The crew and the boats were held until the fine was paid.

Supplementing the vigorous efforts of the Gambian Navy was the passage of a law in Parliament establishing a Fish Marketing Corporation. The corporation has sole authority to license commercial fishing and permit the export of fish or fishery products. The Government's participation in Gambia Fisheries, Ltd., previously owned 80 percent by the Japanese and 20 percent by the Gambian Government, has been increased to 51 percent. This company, which does not have a fishing fleet, but purchases from local fishermen for processing and resale, becomes the operating base for the newly created corporation.

The Gambians, according to a recent statement by President Jawara, took this step to increase foreign exchange earnings and gain greater control of resources. Given the number of fishing boats from other countries in this part of the world and the extent of illegal fishing in Gambian waters, as evidenced by continued detention of foreign vessels, the sensitivities of the Gambians on this subject appear justifiable. (Source: U.S. Embassy, Banjul.)

The Government of Seychelles promulgated a new law redefining the nation's territorial sea and exclusive economic zone last summer. Entitled the Maritime Zones Act, the law was approved by the National Assembly under the previous Government. It entered into force by Presidential decree 1 August 1977.

Under the terms of the Act, the limit of the territorial waters is fixed as the line every point of which is at a distance of 12 nautical miles from the nearest point of the baseline (determined in accordance with the straight baseline system). In addition, the exclusive economic zone is defined as the area beyond and adjacent to the territorial waters extending to a distance of 200 nautical miles from the baseline. The Act also defines the continental shelf and enumerates Seychelles' rights with respect to the exclusive economic zone and the continental shelf.

With respect to foreign ships, the Act stipulates that all foreign ships (other than warships, including submarines) shall enjoy the right of innocent passage through the territorial waters. Foreign warships, including submarines, may enter or passthrough territorial waters after giving notice to the President's office. Submarines, however, must navigate on the surface and show their flag while passing through the territorial waters.

At the present time there is little or no economic activity within the claimed exclusive economic zone. However, the government does plan to make a major effort, with French, British, and perhaps Soviet assistance to develop a fishing industry both to feed the local population and for export. Furthermore, the government recently signed an offshore oil exploration agreement with an international consortium.

The government news agency has reported that Mauritius simultaneously promulgated a similar Maritime Zones Act. It indicated that both laws had been the subject of negotiation and collaboration between the two governments intended to avert any problems arising from overlapping jurisdictions. (Source: U.S. Embassy, Victoria; IFR-77/184.)

Canada's Atlantic Coast Fish Landings Drop Off

Landings in Newfoundland, New Brunswick, Nova Scotia, and Prince Edward Island have declined from 328,823 metric tons (t), in the first half of 1976 to 232,438 t during the same period in 1977 or by 29 percent, according to a report from the U.S. Consulate in Halifax, Nova Scotia.

Newfoundland's landings through June 1977 totaled 116,713 t, a decline of 25 percent from the 155,488 t caught during the same period in 1976; they were worth approximately US$24 million, compared with US$28 million for the first half of 1976.

Landings in the Maritime Provinces (New Brunswick, Nova Scotia, and Prince Edward Island) totaled 115,725 t through June 1977, a decline of 33 percent from the 173,335 t caught during the same period in 1976. There were marked decreases in landings of both redfish and herring, which declined by 86 and 65 percent respectively. Landings in the Maritimes were worth about US$42 million, while landings during the first half of 1976 were valued at US$54 million.

Decreased landings on Canada's Atlantic coast were due to a variety of factors. In Newfoundland, a strike immobilized the trawler fleet from 20 December 1976, until the end of January 1977. Redfish stocks were overexploited during 1976 leading to the imposition of severe quota restrictions on that species for 1977. In the Maritimes, a harsh winter adversely affected fishing conditions with resulting lower catches, particularly of herring and mackerel.

According to the NMFS Office of International Fisheries, representatives of Environment Canada's Fisheries and Marine Service (FMS) were apparently unconcerned over the decline in landings during the first half of 1977. Noting that transitory factors such as weather could affect short-term fishery landings, FMS representatives emphasized that Canada's 200-mile fisheries zone had only recently been

established and that rebuilding Canada's Atlantic fisheries would necessarily take many years.

New Fishery License System Studied for British Columbia

An intensive study of the licensing system for the British Columbia fisheries is being made, according to Canadian Fisheries Minister Romeo LeBlanc. The study will provide recommendations for future licensing and fee structures and is expected to be completed early this year. Sol Sinclair will direct the study. The object of the study is to ensure the optimum resource utilization of both commercial and sport fisheries for Canadian fishermen.

LeBlanc said that the study is particularly necessary in view of both Canada's extension of fisheries jurisdiction to 200 miles and the announcement of the Salmon Enhancement Program for the west coast. Also, radical advances in fishing techniques have led to larger and more efficient vessels, producing distortions and inadequacies in the present licensing system.

While the study is underway, there is a moratorium on all transfers of tonnage to salmon purse-seiners from vessels using other types of gear. This measure prevents Canadian fishermen from catching larger amounts of salmon by using the more efficient purse-seiners and thereby protects the salmon stocks from overexploitation.

Sinclair will be consulting with representatives of fishermen's organizations and other sectors of the fishing industry through spring 1978 by discussing licensing in fishing centers of British Columbia to ensure the broadest possible communication with industry groups.

Sinclair has been a member of the Fisheries Research Board of Canada for 10 years and a member of the Canadian Fisheries Advisory Council under both Romeo LeBlanc and his predecessor, Jack Davis. Sinclair has conducted a thorough study on salmon and halibut licensing for the Pacific region in 1958 and he has also worked in an advisory capacity for the Manitoba government concerning the commercial fishing industry in Lake Winnipeg. For the past 8 years, he has been chairman of the Advisory Committee to the Freshwater Fish Marketing Corporation. (Source: IFR-77/169.)

Norwegians Study Salmon Cholesterol

A Norwegian research team has found that the salmon (*Salmo salar*) produces the same type of cholesterol as humans. In the spring, prior to spawning, the salmon is saturated with this fatty substance; however, when the salmon begins its spawning migration it produces an enzyme which breaks down the cholesterol and provides the burst of energy necessary for the salmon to reach its spawning grounds. It is this enzyme that the Norwegian team is trying to identify. If successful, it is expected that experiments with the enzyme will be conducted on humans. (Source: IFR-77/186.)

EC FISHERY AID TO LDC'S DROPS

The European Communities' (EC) aid to Less Developed Countries (LDC's) is granted through the European Development Fund (EDF). EC aid for fisheries development is also administered by the EDF though to date it represents only 0.75 percent of the total EDF aid to the LDC's (Table 1).

Total EDF aid for fisheries has been declining steadily since the Fund was organized in 1958. The main reason for this decline during the three EDF program periods has been the LDC's lack of interest in fisheries development.

Table 1.—Percentage of fisheries aid to developing countries from EDF funds through 1976[1].

Projects funded	EDF 1	EDF 11	EDF 111	Total
Total	522.589	727.939	870.387	2,120.915
Fisheries	8.623	4.325	2.926	15.874
% of total	1.65	0.59	0.34	0.75

[1]In European units of account (EUA). 1 EUA = US$1.13.
Source: *The Courier*, January-February 1977.

Most fishery aid projects have concentrated on creating infrastructure in the recipient countries (Table 2). In keeping with this trend, a number of fishery development projects planned for the fourth EDF program period will be geared towards improving fish transportation and processing techniques, a major obstacle to fisheries development in the LDC's. Projects will be undertaken in Gambia, Guinea-Conakry, and Ethiopia. In Uganda and Guyana efforts will be made to begin fish meal production.

Additionally, aquaculture projects will be initiated in Benin, Kenya, Lesotho, Swaziland, and Zaire. Emphasis has been placed on developing a country's artisanal sector rather than its deep-sea fishery. For development of the latter, EDF planners prefer to rely on joint ventures between the LDC's and more developed countries. (Source: IFR-77/179.)

Table 2.—Funds allocated for fisheries projects by the European Development Fund since 1958.[1]

Country	Title of project	EDF	Amount in EUA
Benin	Cotton fishing port	EDF II	624,000
	Study of extensions to the Cotonou fish port	EDF III	110,000
	Superstructure for Cotonou fishing	EDF III	540,000
Ivory Coast	Abidjan fish port	EDF I	1,390,000
	New fish quay at Abidjan	EDF II	1,470,000
	Loan on special terms		1,045,000
	Fish preservation	EDF II	2,000
Congo	Study for a fish quay at Point Noire	EDF II	88,000
Mali	Development of fisheries in Mid-Niger (hydrology laboratory)	EDF I	151,000
	Development of fisheries	EDF III	2,126,000
Mauritania	Fish port at Port Etienne	EDF I	2,876,000
	Completion of Port Etienne fish port	EDF II	1,096,000
Senegal	Fish quay at Dakar	EDF I	661,000
Somalia	Study of the development of fisheries	EDF III	150,000
St. Pierre, Miquelon	Fish port on Saint Pierre	EDF I	3,545,000
Total			15,874,000

[1]1 EUA = US$1.13.
Source: *The Courier*, January-February 1977

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